GENSYS COMPACT

PRIME Paralleling unit

User manual - Technical documentation

A56 Z0 9 0020 B EN

Technical documentation history

Date	Doc. version	Comment
June, 2015	A	Initial edition
July, 2015	B	First public release

Preamble

SETTINGS

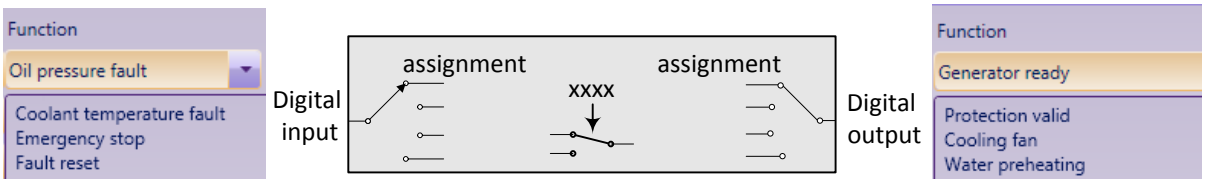
The tables whose header has an **orange**-coloured background describe settings.
Settings (and readings) that show only in CRE Config, but not on the LCD, feature a purple border in the *HMI* chapter as follows:

Setting	Label	Description
xxxx	xxx	*Can be set in any HMI*
xxxx	xxx	*Can be set only in CRE Config*

The setting content is referred to as [xxxx].

In the illustrations:

- Digital inputs and outputs – whether direct or through CANopen – whose assignment is preset in the CRE Config software application show as follows; the shown position has no meaning. Only the inputs Remote start and Generator breaker feedback, and the outputs Fuel and Starter No.1 are mandatory in most cases (for easing reading, they are shown without selector; the emergency stop input is also shown without selector)
- Internal toggles preset through software show as switches with two throws. The code xxxx or the name of the setting shows above:



SYMBOLOGY

	Denotes a threshold monitoring
	Denotes a control loop tuning (three coefficients G, P, I)
	Denotes the need to adjust the amplitude and offset (center)

CRE Technology believes that all information provided herein is correct and reliable and reserves the right to update at any time. CRE Technology does not assume any responsibility for its use.
You can download the most up-to-date version of this documentation and different other documentations relating to GENSYS on our web site http://www.cretechnology.com.

Content

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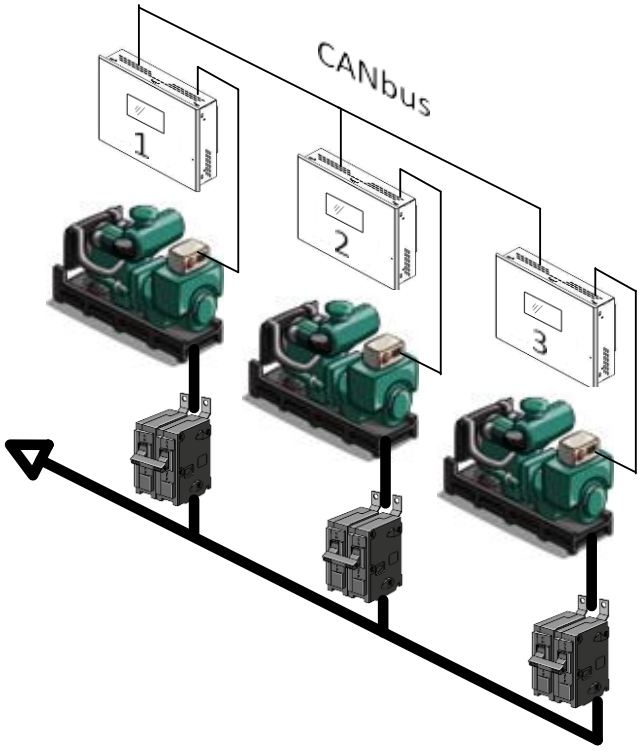
1 PRESENTATION

GENSYS Compact is a panel mounting electronic unit meant for the control of a fuel single, two or three-phase low-voltage generator.
The Prime model is mainly designed to control a generator that operates in an aggregate of generators (up to 32 multiple sets with prime mover and standby sets) in parallel (island mode) with load sharing.
Various generator powers are specified for various usages. Refer to *Appendix: Standard for generators*.

GENSYS Compact capabilities include:

- Start and monitoring of the engine (three 2-wire resistor inputs)
- Acquisition of the engine speed and the generator AC currents and voltages
- Generator electrical protections
- PID control in various modes (isochronous, speed and voltage droop, frequency/volt centering)
- Control of actuators; it is compatible with most speed governors (ESG) and AVR regulators
- Synchronization before coupling
- Extension by CANopen units (Wago, Beckhoff, VIPA, etc): up to 32 extra digital inputs and 32 extra digital outputs
- Link to a PLC or a SCADA via Modbus TCP

In this typical setup, three GENSYS Compact units communicate over a CAN bus to control three generators in parallel:



Heterogeneous aggregate of generators in island mode can be controlled by GENSYS Compact modules. It is preferred that the alternator winding pitches be identical. In any case, all the generators must be controlled by similar GENSYS COMPACT PRIME units.

The engine-generator may have an Electronic Control Unit with CAN J1939 interface. J1939 and CANopen interfaces can coexist – on a second CAN media – provided they use the same bit-rate.
According to the settings, the engine speed is measured by a magnetic pick-up, derived from the AC frequency or provided over a J1939 CAN bus.

Limits on overall active and reactive powers: 65,535 kW and 65,535 kVAR.

1.1 GENERATOR AUTOMATIC CONTROL

Two separate cascade control systems are used:

	Primary control (GENSYS)	Secondary control
Speed	ESG control	ECU or ESG
Voltage	AVR control	AVR

The generated voltages and currents are measured in true RMS and used to calculate the load demand across the aggregate. The synchronization requests and load demand drive the primary control which, according to its configuration:

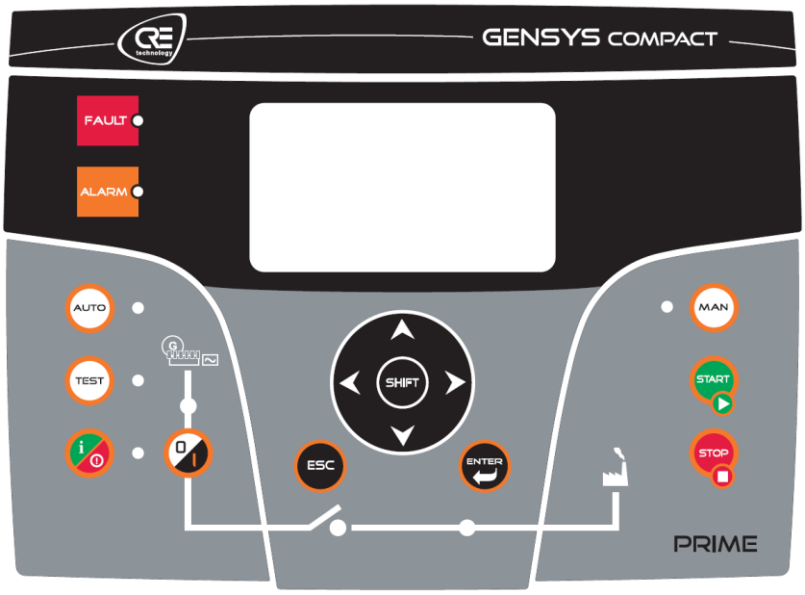
- produces an analog signal Speed out+, sends pulses “+/- f” to digital outputs or writes to J1939 bus.
- produces an analog signal AVR out+ or sends pulses “+/- U” to digital outputs.

1.2 GENERATOR BREAKER CONTROL

When GENSYS has synchronized the generator and bus bar, it closes the breaker relays (coupling); this can also be done manually: locally (front button) or remotely (if configured so). All the related digital inputs and outputs are configurable.

Two coils can be controlled simultaneously.

1.3 HUMAN-MACHINE INTERFACE

<table>
<tr><td></td><td colspan="4">Back-lit auto-off LCD</td></tr>
<tr><td>The led blinks after a fault arises.
Acknowledged by pressing the lower button</td><td colspan="4" rowspan="3"> 
</td></tr>
<tr><td>The led blinks after an alarm arises.
Acknowledged by pressing the lower button</td></tr>
<tr><td>Press to switch to automatic mode. Led is lit when this mode is activated</td></tr>
<tr><td>Press to switch to test mode (starts the gen. & closes breaker). Led is lit when mode is activated</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Press to access:
.the Fault page if new fault occurred (Fault blinks)
.the Alarm page if new alarm occurred (Al. blinks)
.pages with 2 statuses (Power and Engine) and 10 readings of special interest.
Press again to return.</td><td colspan="4">Led Gen. ready</td><td>Manual mode</td></tr>
<tr><td>In manual mode:</td><td>Closes/opens generator breaker</td><td colspan="2">Navigation/Edition (see below)</td><td>Starts/ stops generator</td></tr>
<tr><td colspan="4">Breaker status led (lit when closed) Bus status led (lit when live)</td></tr>
</table>

Keyboard:

Keys	Navigation mode	Edition mode
▲ ▼	Cyclic navigation through menu & settings list	Used to change the value of a setting. Hold down to change faster
◀ ▶	Cyclic navigation through pages when an item is selected in a menu and validated	–
Shift	Used with ▲▼ to in/decrease LCD luminosity Used with ◀▶ to adjust LCD contrast	When in manual mode and breaker is open, used with ▲▼ to increase/decrease: ▪ speed command on Speed control page ▪ voltage command on Voltage control page
	Used with to reset alarms and faults	
Esc	Return to parent menu (3 times to home) or preceding menu	Setting change rejection and return to the Navigation mode
Enter	Page opening / switch to Edition mode	Validation of the new setting and return to Navigation mode

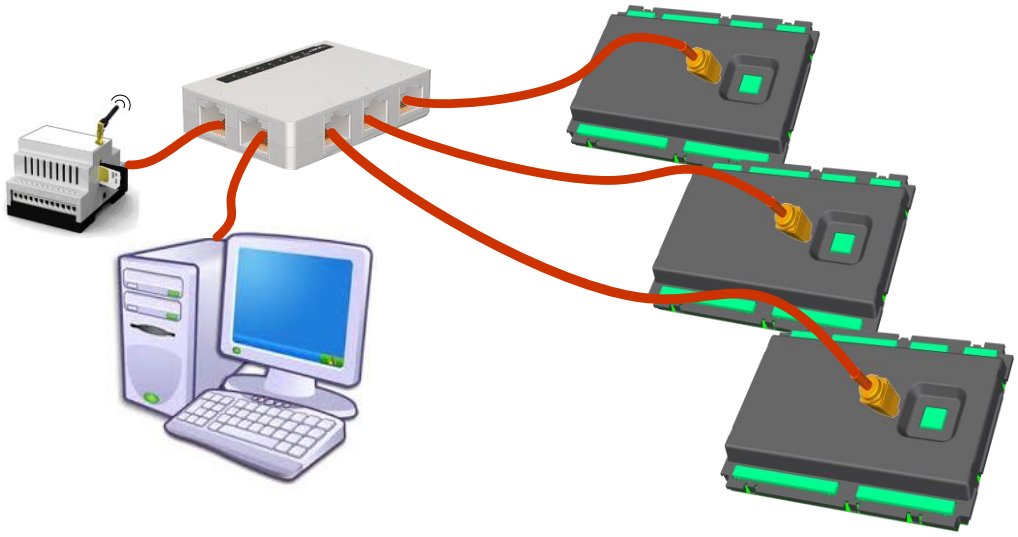
1.4 START AND POWER MANAGEMENT

GENSYS units in an aggregate share information through CAN bus communication. Various start strategies can be implemented to match your needs:

- In **dynamic** paralleling, the generators are **selectively** started and synchronized to the already running units. Then they can be stopped and restarted according to the load demand ("Load-Dependent Start-Stop").
- In **static** paralleling (emergency start), the generators are started **simultaneously** and the warm-up is by-passed.

1.5 SETTING AND SUPERVISION UTILITY

A Windows™ PC with the software application CRE Config 2.50 or later must be connected on the rear Ethernet socket, generally via a switch in a star network:



This allows you to preset all the GENSYS units when they are on desk: a text file that reflects the first GENSYS unit's configuration can serve as a template to deploy the setup to the other GENSYS units in the cluster. The CRE Config multi-tabbed interface makes it easy.
Once all GENSYS units are mounted, CRE Config can be used to set them up and monitor the generators. The CRE Config features a Scada section that can be used in particular as an event console to GENSYS:

	GENSYS	CRE Config/Scada
Event console		Time | Label | Variable | State 0h00 | Breaker fault | xxxx | 1
Information display	Information Power Engine Prod request 1 Mode AUTO	Label | Variable | Value Prod request | xxxx | 1 Mode | xxxx | AUTO
Event logger	→ 2,000 2 1 →	

1.6 ASSOCIATED PRODUCTS FOR REMOTE METERING, MONITORING AND CONTROL

The readings, and alarms-faults raised by GENSYS can be transmitted over a wired Ethernet network through the CRE Technology boxes BSD Plus (see preceding illustration; it embeds a website) or BSD2.0 (illustrated herein; it uses the IaaS cloud technology):

The data server stores the data and forwards e-mails to notify alarms-faults (SMTP).
Antennas provide wireless capabilities:

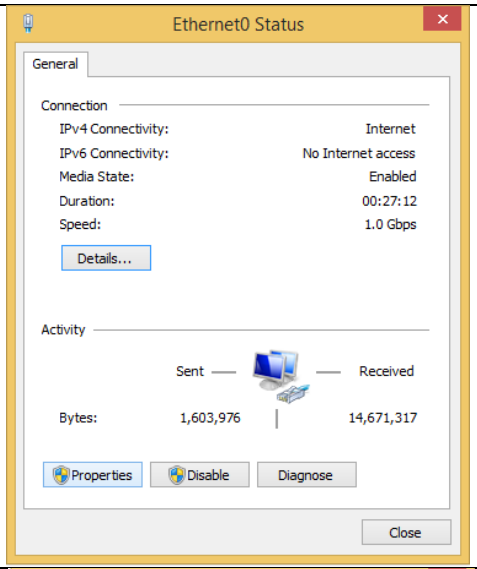
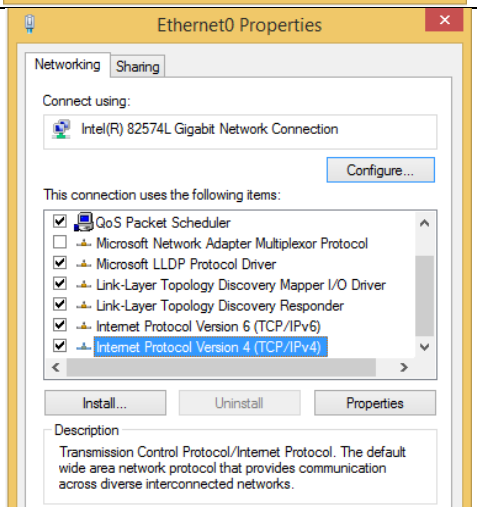
- 3G/GSM/GPRS (insert a SIM card into the slot); SMS service is supported by BSD Plus
- GPS (geo-localization; geo-fencing is supported by BSD 2.0).

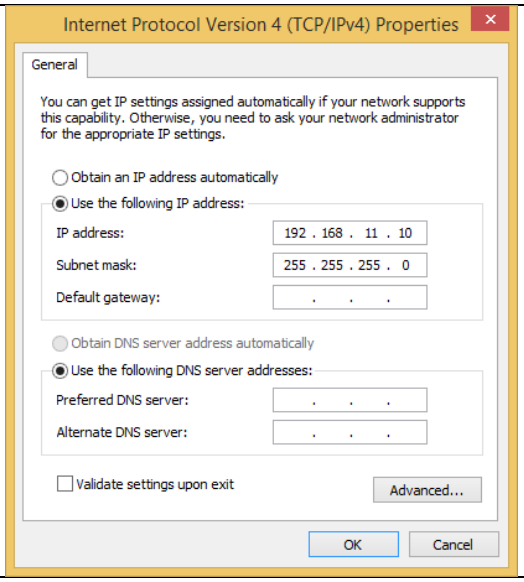
The alarms-faults can be remotely reset, and the generator started in any mode. The writing rights are those defined for Modbus TCP. Trend analysis and tunneling (direct connection to GENSYS) are available with BSD 2.0. Refer to the dedicated manual.

2 INSTALLATION

2.1 ON-DESK ETHERNET SETUP

2.1.1 Setting the PC connection

Connect GENSYS to a PC with a 100Ω Ethernet cord	Direct connection to PC: use a crossover cord. Connection through a switch: use a direct cord; a crossover cord such as 3-m long A53W1 is OK if the switch manages it.
Power up GENSYS using a stabilized power supply	Power supply range: 8…35VDC
Open Windows control panel	
Click: • Local network (Windows XP) • Network and Sharing Center / View status (Windows Vista) • Open Network and Sharing Center/Change adapter settings/(Connection to) LAN/ Properties (Windows 7 & 8)	
Click Parameters (Windows XP) or Properties (Windows Vista or 7 or 8)	

Select TCP/IP or TCP/IP v4, and click Properties	
Enter a PC address that differs from the one of the GENSYS only by the last number, & click OK	Last number: 0 … 255; avoid 0 and 255 as they are often taken for other purposes

2.1.2 Changing the GENSYS IP address

To change GENSYS IP address, in CRE Config (or on LCD), navigate to “System/Network configuration (resp. About)”.
GENSYS supports the DHCP function: in this case, GENSYS must be connected on a network with a DHCP server. During the power-on sequence, GENSYS is assigned an IP address by the DHCP server. If DHCP process fails, the fixed IP address is used (factory setting: 192.168.11.1).

Note: Contact your network administrator to configure your router and module(s) to your needs.

2.1.3 Hostname

You can assign an alias to GENSYS, in addition to the IP address; enter it in CRE Config to get connected.
To change this alias, in CRE Config navigate to System/Network configuration.
Maximum length: 16 characters. With Windows, the last character defines the type of service (0 is the usual value).
Allowed characters: reduced ANSI set; "-" and "." are allowed except at the start and end.

2.1.4 Copyright

GENSYS Ethernet communication uses the open source lwIP TCP-IP stack. Read copyright/disclaimer below. More details on lwIP Web site: http://savannah.nongnu.org/projects/lwip/

2.2 IN-PANEL INSTALLATION

The unit is designed for panel mounting, which provides user with access only to the front panel.

WARNING
THE UNIT IS NOT GROUNDED
Take all measures against Electronic Static Discharges. Do not try to open the unit.
Failure to follow these instructions may damage the unit

Environmental requirements:

- Operating temperature: -30°C (-22°F) … 70°C (158°F); LCD display slows down a bit under -5°C (23°F). Avoid direct exposure to the sun
- Storage temperature: -40°C (-40°F) … 80°C (176°F)
- Altitude: up to 2,000 m (6,561 ft); on higher altitudes, recommended max. AC voltage : 100VAC

2.2.1 Unpacking

Make sure the packaging contains:

- the unit
- four caps + screws packaged apart
- a delivery bill

Unpack and keep the packaging in event of return.
Make sure the unit does not show scratches or visible defaults. Otherwise describe them on the RMA sheet (downloadable from CRE technology Web site).

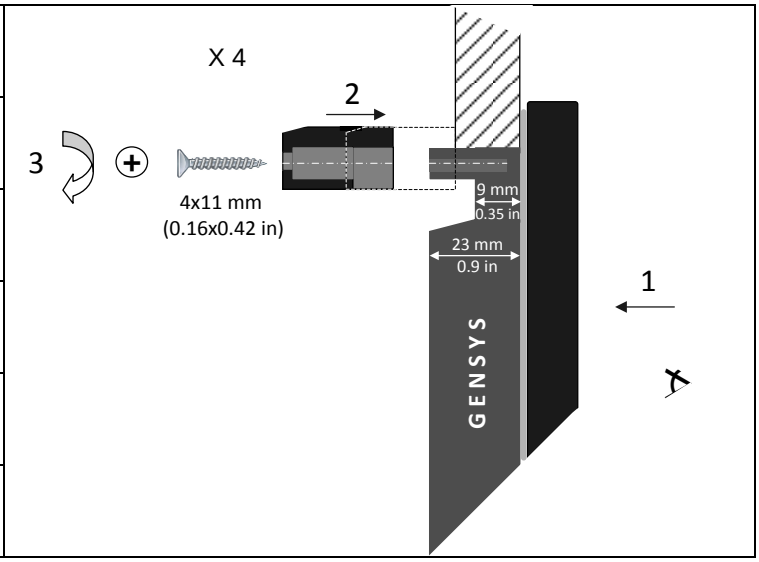
2.2.2 Installation

Preparation

1. Cut out the panel to 220x160 mm minimum (8.7 in x 6.3 in)
2. Make sure the cut-out is smooth and clean

Mounting

0	Tool: cross-head screwdriver size 1
1	Pass the unit through the panel
2	In the rear, cover each of the four spacers with a cap
3	Screw a cap against the panel
4	Repeat on the diagonally opposite spacer
5	Repeat on the other diagonal and tighten equally (do not overtighten)



2.2.3 Wiring the unit

Tool: insulated screwdriver Ø2.5 mm (0.1 in), tightening torque: 0.8 Nm (7 lb-in) max.

Accessories: 4, 5, 6, 8, 15 & 18-terminal cable connectors, protective gloves, carpet if the floor is wet.

⚠ WARNING
THE UNIT IS NOT PROTECTED
Use external fuses: ▪ Bus bar and Generator phases: 100mA/600VAC ▪ Battery positive: 5A/40VDC Install the fuses as near as possible the unit, in a place easily accessible to the user. The disconnection device must NOT be fitted in a flexible cord.
Failure to follow these instructions may damage the unit

⚠ DANGER	
	**HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH** ▪ The unit must only be installed and serviced by qualified electrical personnel ▪ Apply appropriate personal protective equipment (PPE) & follow safe electrical work practices ▪ Turn off power before installing or removing fuses, and before installing the unit ▪ Use a properly rated voltage sensing device to confirm the power is off ▪ Do not use renewable link fuses in fused switch
	Failure to follow these instructions will result in death or serious injury

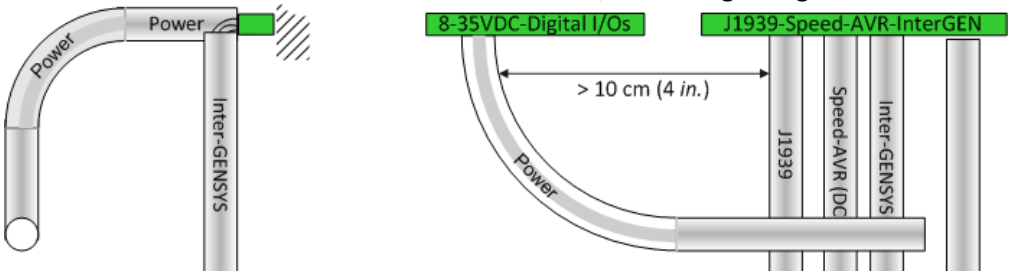
General procedure

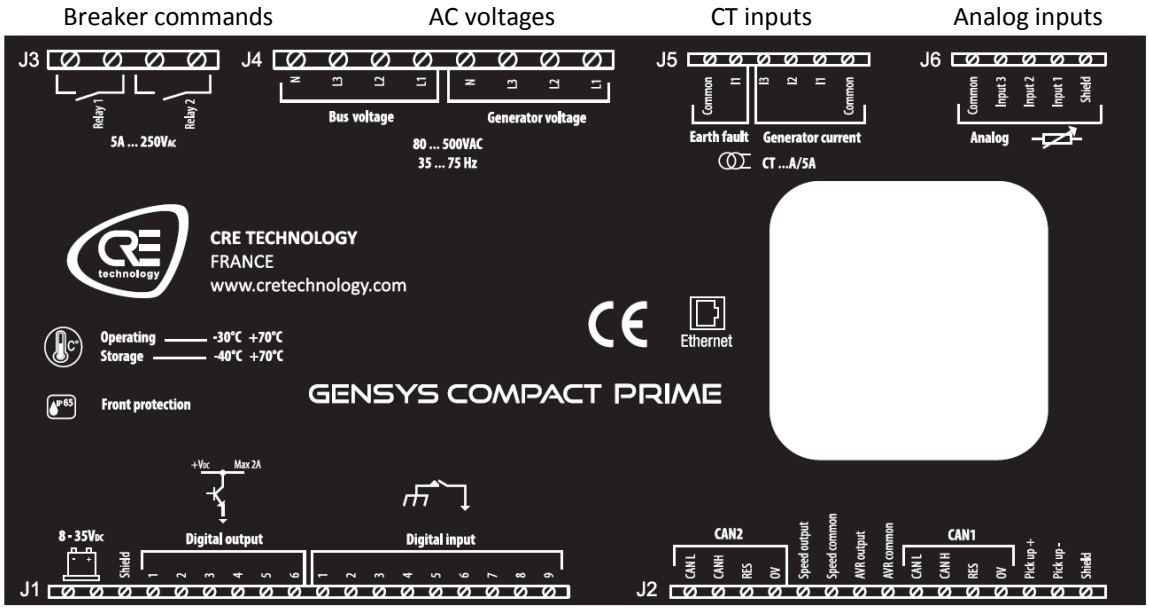
1. Make sure the cable connectors are NOT plugged
2. Take on protective gloves
3. Connect the wires on each cable connector in accordance with the National Wiring Regulations
4. Plug each cable connector onto the related connector
5. Plug a direct Ethernet cord (RJ45, male-male, 100 m max., 100Ω; a crossover cable such as 3-m long A53W1 is OK if the switch manages it or if the link to PC is direct) and lock the rear door.

Recommendations

Wires section: 2.5 mm² (AWG13).
To avoid ElectroMagnetic Interferences, shield cables appropriately; for CAN bus, see the Appendix CAN bus Good practices.
Segregation: keep the power cable separate from the CAN bus cables. The latter can be installed in the same duct as the low level DC I/O wires (under 10V).

If power & communication cables have to cross each other, do it at right angles to avoid crosstalk:





8-35VDC-Digital I/Os

CAN2-Speed-AVR-CAN1-pickup

Upper blocks

⚠ DANGER

EXPOSED TERMINALS

Do not touch terminals L1, L2, L3 nor use non-insulated tools near them. These terminals are unprotected and will expose the user to dangerous voltages

Failure to follow this instruction will result in death, serious injury or equipment damage

Block and mark	Description	Note
Breaker commands		Normally open. Breaking capacity: 5A, 240VAC
Relay 1	Relay 1 +	
	Relay 1 –	
Relay 2	Relay 2 +	
	Relay 2 –	
AC voltages		100-480VAC, measure range: 35 … 75Hz, 100mA max; accuracy: 1% fsd
N	Bus N	Option
L3	Bus L3	These lines must be protected externally with 100mA/600V_{AC} fuses. Use two PTs of 2VA (Phase-to-phase)
L2	Bus L2	
L1	Bus L1	
N	Generator N	Option
L3	Generator L3	These lines must be protected externally with 100mA/600V_{AC} fuses. 1VA (Phase-to-neutral)
L2	Generator L2	
L1	Generator L1	
CT inputs		These lines must be protected externally against short circuits
Earth common		*GND*
Earth fault	*Stator earth current*	*Protection on earth fault not implemented yet. Don't hesitate to contact CRE Technology for more information*
Gen current I3	Generator I3	0… 5A. Maximum rating: 15A during 10s. Burden: 1VA. Keep the lead length short to preserve accuracy (up to 0.5% full scale deviation) External CT max ratio is 3250 (i.e. 3250:1 or, preferably, 16250:5).
Gen current I2	Generator I2	
Gen current I1	Generator I1	
Gen common	GND	Optionally connected to CT –. For a 2-CT setup, see further
Analog inputs		0-500Ω
Common		Connect it to Battery –
Input 3	Free input	
Input 2	Free input	
Input 1	Free input	

Block and mark	Description	Note
Shield	GND	Ground plane

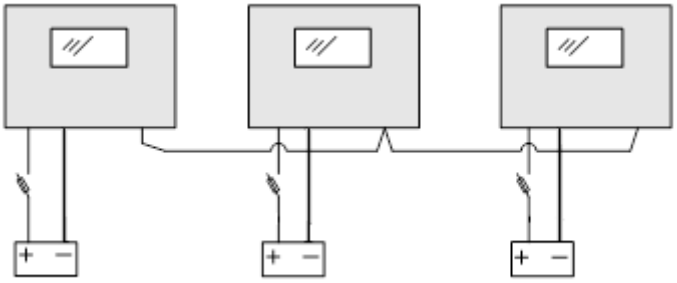
Lower blocks

WARNING

RISK OF EQUIPMENT DAMAGE

As a protection against polarity reversal, install a 6A fuse between Battery positive lug & terminal 8-35VDC +.
Connect battery negative to GENSYS terminals 8-35VDC– with 2.5 mm² (AWG13) cable.

Failure to follow this instruction can damage the controller



Block and Mark	Description	Note
8-35VDC		NOT protected against polarity reversal
+	Power supply +	8…35VDC, consumed current: 130 mA at 24V (standby & operation)
–	Power supply -	2.5mm² (AWG13)
Shield	GND	Generator chassis
Digital outputs		Free solid state output. State 1 at the supply voltage (max: 2A). Protected against short circuits. A reactive load is supported. Not isolated from power.
1	Starter n1 generally	
2	Fuel generally	
3	Other free outputs	
4		
5		
6		
Digital inputs		Free digital input with 10kΩ pull-up. Accepts NO or NC contact to 0V. Not isolated from power.
1	Gen bk fb generally	
2	Remote start-stop	
3	Other free inputs	
4		
5		
6		
7		
8		
9		
CAN2: J1939-Extensions		Isolated CAN bus J1939/CANopen. Twisted pair. See *CAN appendix*
	CAN L	Blue wire
	CAN H	White wire
	Resistor –	Strap to CAN H when inner resistor must be inserted (bus ends)
Shield	0V	Connect the cable shield herein
Speed		Compatible with most speed governors. Isolated from power
Out	Speed output	±10V analog output to speed governor

Block and Mark	Description	Note
common	Speed reference	Twisted pair; length < 5m (16ft) if unshielded, < 50m max if shielded
AVR		Compatible with most regulators. Isolated from power
Out	AVR output +	Analog output ±10V
common	AVR output –	Twisted pair; length < 5m (16ft) if unshielded, < 50m max if shielded
CAN1: Inter GENSYS		Isolated CAN© bus, use twisted pair. Refer to the *CAN appendix*
	CAN L	White wire with a blue strip (when using a CRE cable)
	CAN H	Blue wire with a white strip (when using a CRE cable)
	Resistor –	Strap to CAN H when inner resistor must be inserted (bus ends)
Shield	0V	Connect the cable shield herein
Pickup		100Hz to 10kHz. Voltage limits between + and –: 2-40VAC
	Pickup + Pickup –	Speed measurement for speed regulation, crank drop out and over-speed. Better option than alternator voltage. An over-speed shutdown device independent of GENSYS is required; the alarm can be generated by ECU (refer to the chapter *J1939 Communication*) or by GENSYS (refer to the chapter *Protections*)

⚠ WARNING

RISK OF EQUIPMENT DAMAGE

Switch off the unit before plugging or unplugging the CAN bus connector or disconnecting wires

Failure to follow this instruction can damage the CAN transmitter/receiver

Note: Crank dropout: the unit survives for 70 ms at 24V, and 20ms at 12V.

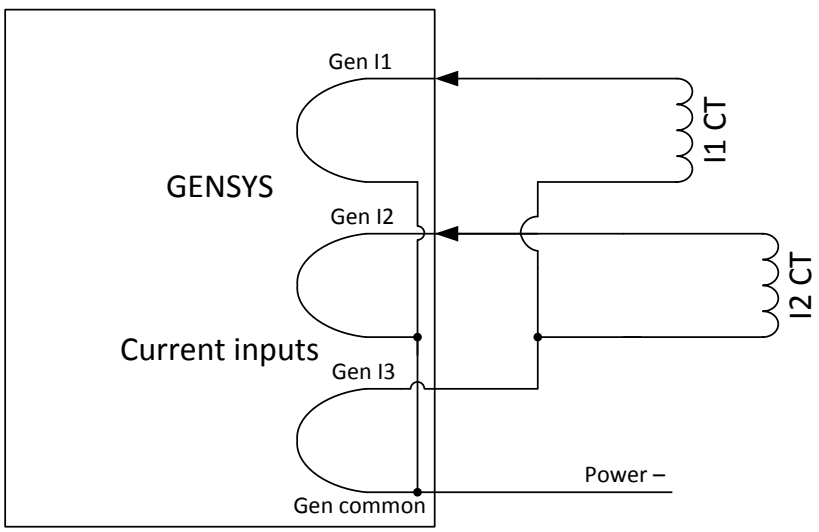
Other systems of voltage

If Biphase 180° is selected in CRE Config, connect voltages and currents to terminals L1-L3 (and N), resp. I1-I3 (and common).

If Monophase is selected, connect voltages and currents to the terminals L1-N, resp. I1 and common.

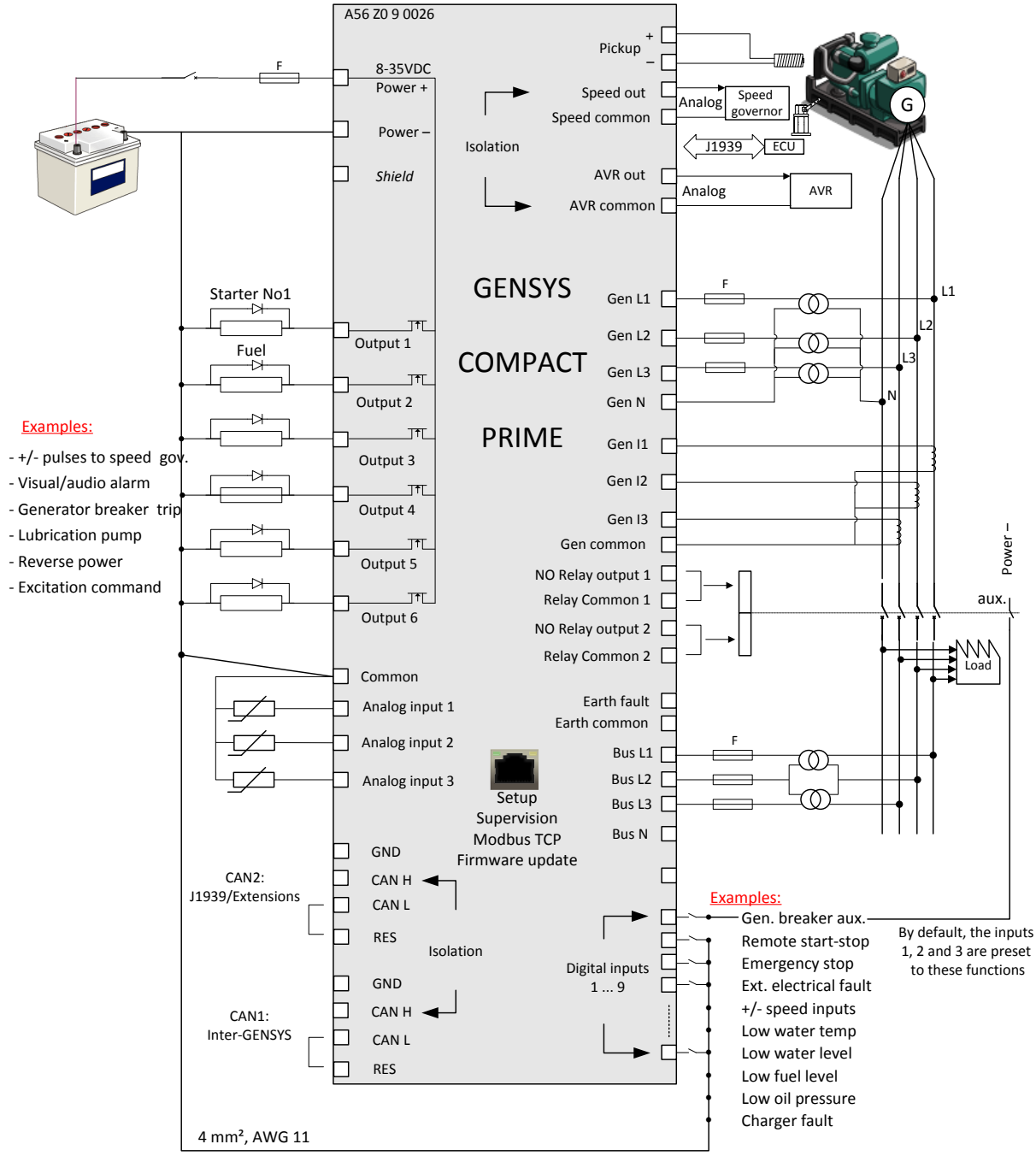
Current measurement by only two CTs

The 3-phase system must be balanced; therefore I3= – I1 –I2 and only two identical CTs are required:



This is used in middle-high voltage applications. The I3 value is less accurate.

2.2.4 Connection diagram



The diagram shows that the Potential Transformers can be connected in various ways:

- Star (wye) on generator side (1 insulated high-voltage terminal per PT) ; the ratio is for example
$$\frac{\mathrm{Unom}/\sqrt{3}}{100/\sqrt{3}}$$
- Vee on bus side (2 insulated high-voltage terminals per PT) ; the ratio is for example
$$\frac{\mathrm{Unom}}{100}$$

3 OPERATION

3.1 OPERATING MODES

GENSYS can control the generator in three modes. They are activated through buttons:

Mode	Button-Led	Use
Automatic	AUTO	Refer to chapter *Applications*
Manual	MAN	Refer to chapter *Commissioning*
Test	TEST	Used only to check the start sequence of the generator taking the load. To exit this mode, press either **AUTO** or **MAN**

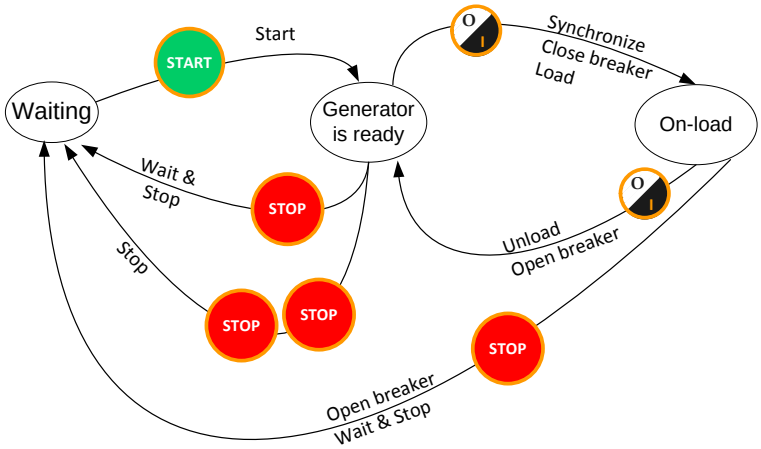
3.1.1 Manual mode

1. Press **MAN**: this lights the associated LED
2. Press **START**: GENSYS starts the engine (this is detailed further)
3. Press the generator O/I button to switch the generator ON the load. Depending on the setup, the process can include:
   - synchronization (if bus bar is live)
   - closing of the generator breaker
   - loading of ramp (if bus bar is live)

GENSYS manages the load according to the setup.

4. Press the generator O/I button to switch the generator OFF the load; this may imply unloading the ramp (paralleling) and opening the generator breaker; the engine runs on

5. Press **STOP**
   - One time to cool the engine down and stop it when the time is up
   - Two times to stop the engine right away



Pressing **STOP** when the generator breaker is CLOSED starts the standard unload sequence, opens the breaker and stops the engine after cool down.

3.1.2 Automatic mode

The automatic mode is subjected to a digital input assigned to the function Remote start (of generator start sequence).

Until the digital input is activated (and any delay expired), the Auto mode does not prevail. To set delays, refer to the chapter *8.3.1, p.105*. If the input is de-activated, GENSYS is considered as unavailable.

3.1.3 External requests

You can substitute the front panel buttons for external buttons/PLC commands connected to a pair of digital inputs.
The external requests control the Led in the same manner as the local buttons. The last request (external or front panel) override the others.

MAN/AUTO

If both signals contradict each other, the Manual mode request overrides the Auto mode request.

START/STOP and Increase/Decrease

Regardless of the mode, you can start/stop the engine or increase/decrease the speed/voltage:

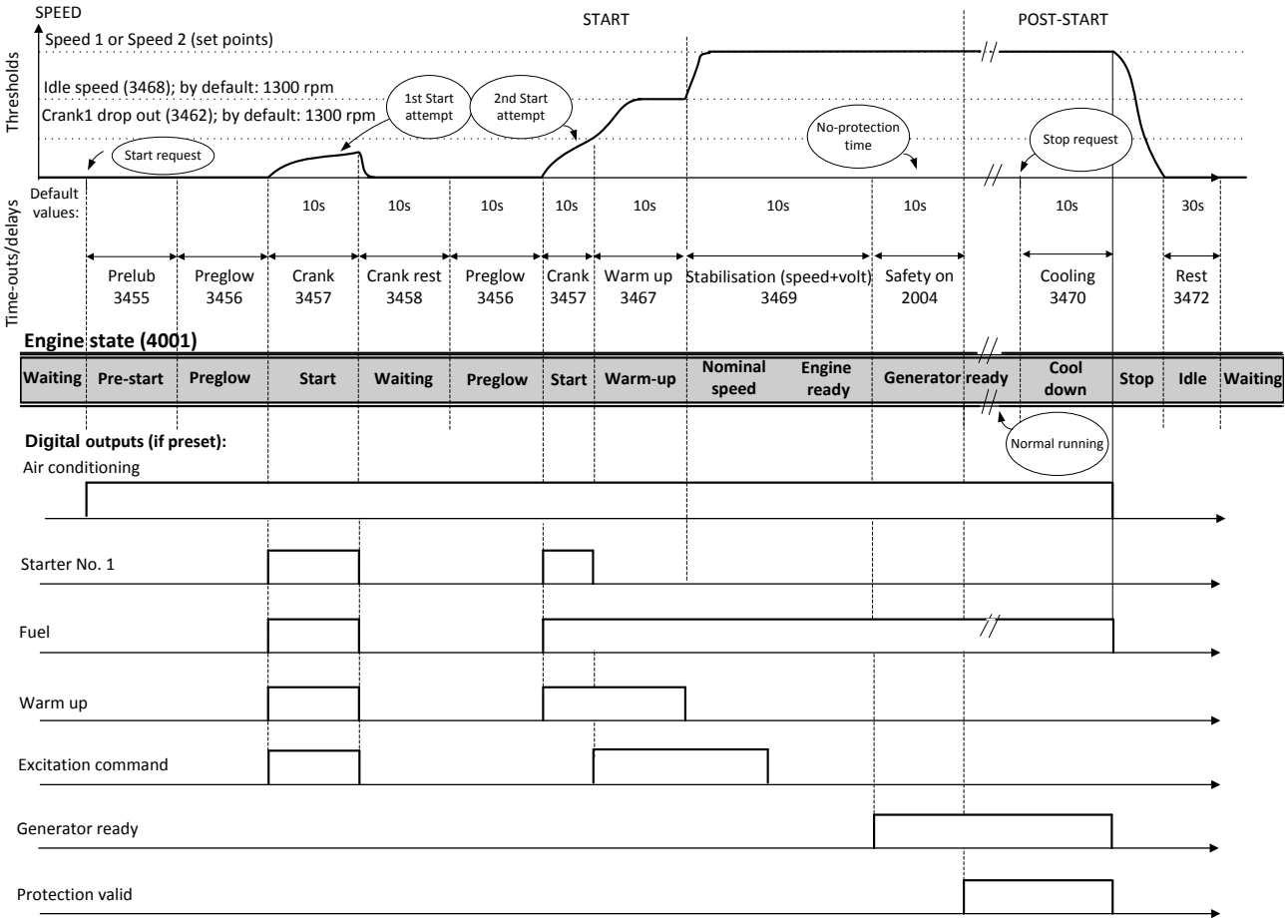
Local buttons	Substitute function
START / STOP	Manual start/stop request
Shift + ⮝ / ⮟	Increase/decrease speed in man. OR Increase/decrease voltage in man.

3.2 START SEQUENCE

3.2.1 Internal Start sequence

During the start sequence, GENSYS controls the prelub, preglow, crank and fuel outputs when proper conditions are met, whereas the protections are inhibited. This concerns all engine protections.
Main start phases:

1. The engine is considered to have started when the speed reaches the crank drop out
2. The engine gets ready
3. The generator gets ready; the protections are activated unless the "Safety on" delay [4852] is set to protract inhibition



Digital inputs can be preset to Start-related functions:

- Only start generator: run without paralleling nor closing breaker
- Start inhibition: no start whatsoever (even in manual mode)

Digital outputs can be preset to states:

- Generator stop: activated as long as the engine is in state Waiting
- Prelubrication : activated during prelubrication
- Water preheating : activated during preheating
- Preglow: activated during preglow (spark plug)
- Warm-up: activated during warm-up. Inhibited during emergency start if any
- Engine not ready: activated until the speed set point is reached
- Generator ready: activated as the speed set point is reached and voltage is present
- Protection valid: activated when the protections are enforced (expiry of Safety on)

Note: Make sure the speed threshold [3468] is below or equal to [3462].

Setting	Label	Description
3453	Fail to start engine t-o	Maximum time allocated to start. Default value: 10.0s
Status	Label	Description
	Fail to start engine	Activated if engine has not started until 3453 has expired or 3461 has been passed

Conditions before start-up

GENSYS monitors the oil pressure and water temperature:

1. Prelubrication check: the oil pressure must be ABOVE the threshold [3473]
2. Preglow check: the water temperature must be ABOVE the threshold [3474]

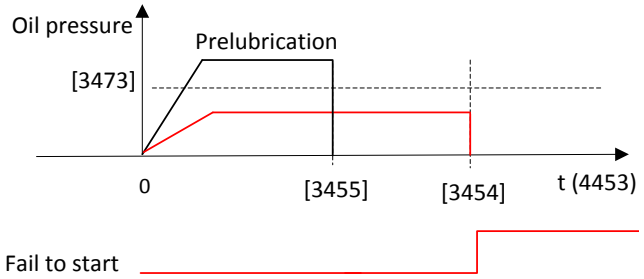
Setting	Label	Description	Note	Default value
3473	Oil prelubrication	Oil pressure low threshold		0mbar
3474	Water temp.	Water temp. low threshold	Digital input Preheating required in auto mode	0°C

If you give them the thresholds the value 0, the readings from the analog sensors are not checked before start-up.

When both values are OK, the output Air conditioning is activated (provided an output is preset accordingly).

When 3454 expires, if either reading is below its threshold or the speed is below the set point, the fault "ENGINE not ready" appears.

Setting	Label	Description	Associated clock in Scada
3454	Max prelub t-o	Max. time allocated to engine to prestart. Default value: 10.0s	Prelub timer 4453
Status	Label	Description	Associated digital output
	Not ready	Activated if no pre-start until 3454 has expired	Engine not ready

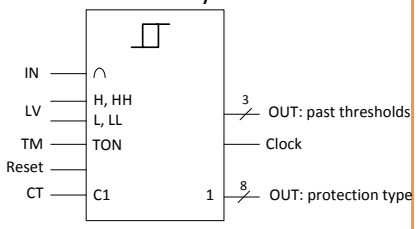


Success: prelubrication can be resumed later manually or on external fault (see next time chart).
Failure: the starting sequence stops.

Protections

GENSYS can activate protections:

- below the oil low threshold or above the water high threshold, the "ENGINE not OK" information shows
- the attribute CT of the threshold determines the protection type (8 values; see *Protections*) to which the signaling contributes; A digital output can be configure according to this protection.

Setting	Related	Label	Description	Validity	Function block
2362	–	LV min oil	Oil pressure **low** threshold	After stabilis.	The output shows the status with respect to the two thresholds; it is incremented/decremented when a threshold has been trespassed for its delay TM:  CT: 8 potential effects.
	2363	TM min oil	Oil pressure min timer		
	2364	CT min oil	Action on oil pressure min passed		
2380	–	LV2 min oil	Oil pressure **very low** threshold		
	2381	TM2 min oil	Oil pressure min timer		
	2382	CT2 min oil	Action on oil pressure min passed		
2365	–	LV max wat. t°	Water temper. **high** threshold	Always any state	
	2366	TM max wat. t°	Water temperature max timer		
	2367	CT max wat. t°	Action on water temp max passed		
2383	–	LV2 max wat. t°	Water temp. **very high** threshold		
	2384	TM2 max wat t°	Water temperature max timer		
	2385	CT2 max wat. t°	Action on water temp max passed		

Manual mode

In manual mode, the start request is manual, the stop is automatic (protection) / manual (request).

If a digital input and a digital output are associated to one function (refer to the chapters *8.3.1 p.105* and *8.3.2, p.107*), they are interconnected.

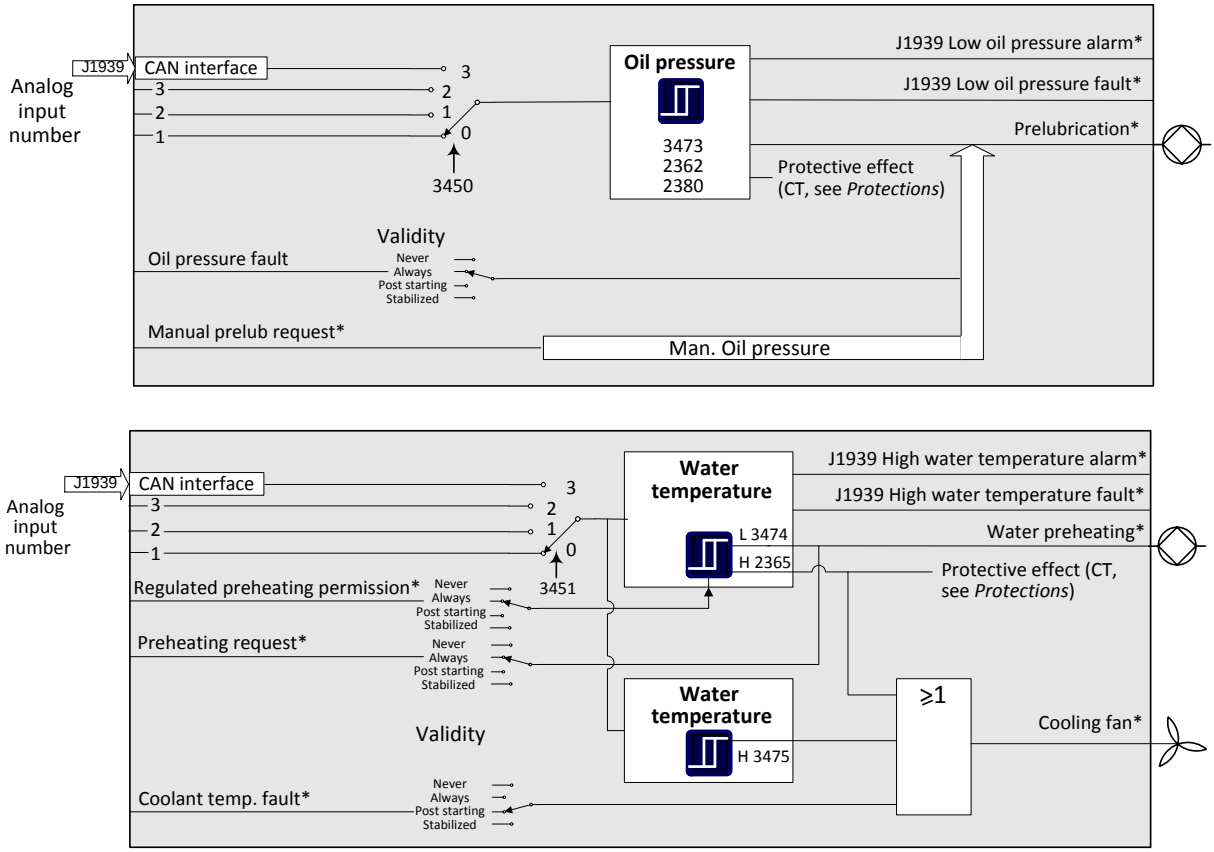
Function	Parameter	Sensor
Prelubrication	oil pressure	not required
Preheat	water temperature	not required

Summary

A J1939 value has priority over an analog input. To dismiss a J1939 analog value, set the related switch to the desire analog input.
GENSYS does not take into account an oil pressure fault during the start sequence.

Note: Preheating (with validity = Always) is used in Auto mode, Manual preheat request in manual mode.

In next illustrations, the typical set-up is through the switch 3450/3451.
Alternately, GENSYS receives the fault signal through a digital input whose validity is configured for a given engine state (refer to *8.3.1*); then, to by-pass the internal processing, set the GENSYS threshold to 0.



* Assignment of a direct or remote digital input or output in CRE Config
Usual validities are shown. They are preset in CRE Config at the same time as the function. Refer to *8.3.1, p.105*.
Cooling fan is also actuated in manual mode if the engine runs.

Setting	Label	Description
3473	Oil pressure threshold	Lubrication pump run below this low pressure threshold. Set to 0 to bypass prelubrication.
3474	Preheat coolant temperature threshold	Preheating pump run below this low temperature threshold. Set to 0 to bypass preheating.
3475	LV cooling	Air fan is activated when water temperature is over this threshold (default value: 40°C). Air fan is not active when engine is stopped

Crank

With multiple starters, preset digital outputs to Crank2 and Crank3. The Starter number depends on the preset output number. The starters are attempted according to the starter numbers as far as the engine fails to start.

Setting	Label	Description	By default
3459	Starter order	Starter alternance type: **0**: one attempt per starter per round (the starters take the token after one another). In CRE Config, select "Alternative" **1**: each starter makes several attempts in a row. In CRE Config, select "Consecutive"	0
3460	1st starter	Number of the first energized starter	1
3461	Start Attempts	Maximum count of start attempts allowed by starter. Value: 0…15	3

Examples with 3 starters, with 1st starter set to 2 and number of start attempts configure to 3:

- In alternative mode, the sequence will be.2-3-1-2-3-1-2-3-1
- In consecutive mode, the sequence will be 2-2-2-3-3-3-1-1-1

Note: For each starter's functions (starters 1 to 3), in "Configuration/Engine/Start settings" there are separate lower thresholds under which the starter drops out. The values depend on starter type (electric, pneumatic...).

3.2.2 Idle speed

To prevent a cold engine to run at full speed, GENSYS can run it at idle speed for a short time on startup.

For this purpose, GENSYS feeds a "warm up" command to an external speed controller with idle speed input when the engine is in states "Start", "Warm up".

The idle speed is fixed by the speed controller. Parameter 3486 allows to command a speed ramp.

Setting	Label	Description
3468	Idle speed	Speed set point in pre-start.

3.2.3 Smoke limiting

To prevent a cold engine from over-emitting, GENSYS can run it at idle speed for a short time on startup.

For this purpose, GENSYS feeds a smoke limiter command to an external speed controller with smoke limit input when the engine is in states "Start", "Warm up" and "Nominal speed".

3.2.4 External auto start module

Some engines are equipped with an Automatic Start Module (ASM). On start (automatic/test/manuel mode), GENSYS empowers it to energize the crank and fuel and to synthesize the engine alarms/faults.
The setup depends on the type of ASM:

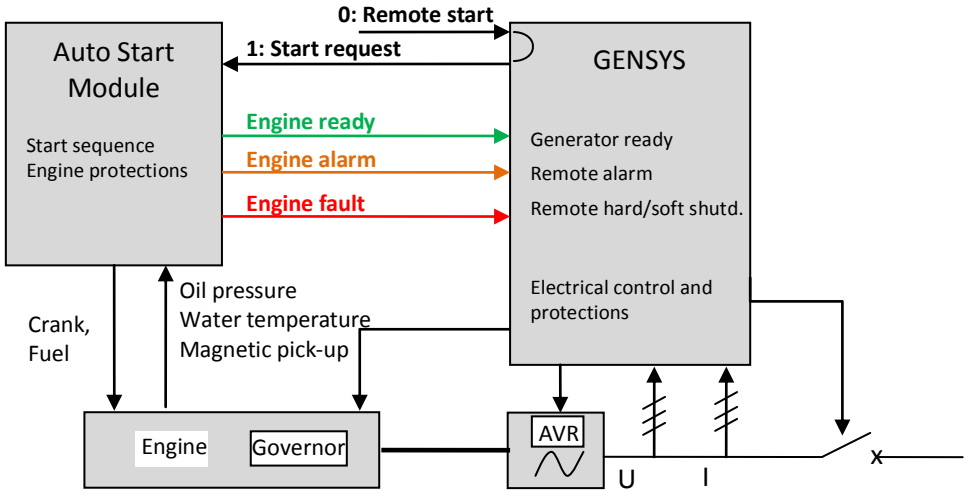
COMMON

Step	Presetting	Connections to ASM
0	To inhibit GENSYS internal start sequence, activate "External start sequence" in "Configuration/Engine"	
1	In CRE Config/Configuration/Outputs/Digital outputs, preset a digital output to Start request	Connect it to a start request input (it replaces the GENSYS fuel output)
2	In CRE Config/Configuration/Inputs/Digital inputs, preset a digital input to Remote alarm	Connect it to an engine alarm output
3	In CRE Config/Configuration/Inputs/Digital inputs, preset a digital input to "Remote hard shutdown" (immediate engine stop) or "Remote soft shutdown" (stop after cool-down sequence). See further	Connect it to an engine fault output

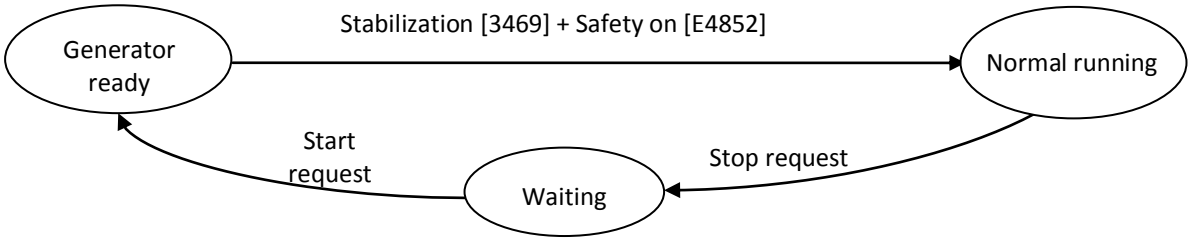
As with a GENSYS-controlled start, the engine start time-out [3454] applies.

ASM with a "Generator ready" digital output

Step	Presetting	Connections to ASM
4	In CRE Config/Configuration/Inputs/Digital inputs, preset a digital input to "Generator ready"	Connect it to an engine ready output



When ASM validates the speed, it sends the signal of readiness, and GENSYS regains the control:



ASM without a "Generator ready" digital output

No extra presetting. In absence of Engine fault, at expiry of stabilization timeout [3469], GENSYS declares the generator readiness if the speed and voltage are valid.

3.2.5 Power delivery

The sequence depends on the paralleling type (refer to the chapter *Applications*):

- Dynamic paralleling: the excitation, generated with the crank output, is activated in the states Start, warm up, and nominal speed
- Static engine paralleling: the excitation, sent apart, is activated in the states Engine ready, generator ready

The succeeding states of the generator can be followed locally, in the Information page (variables 4000 and 4001).

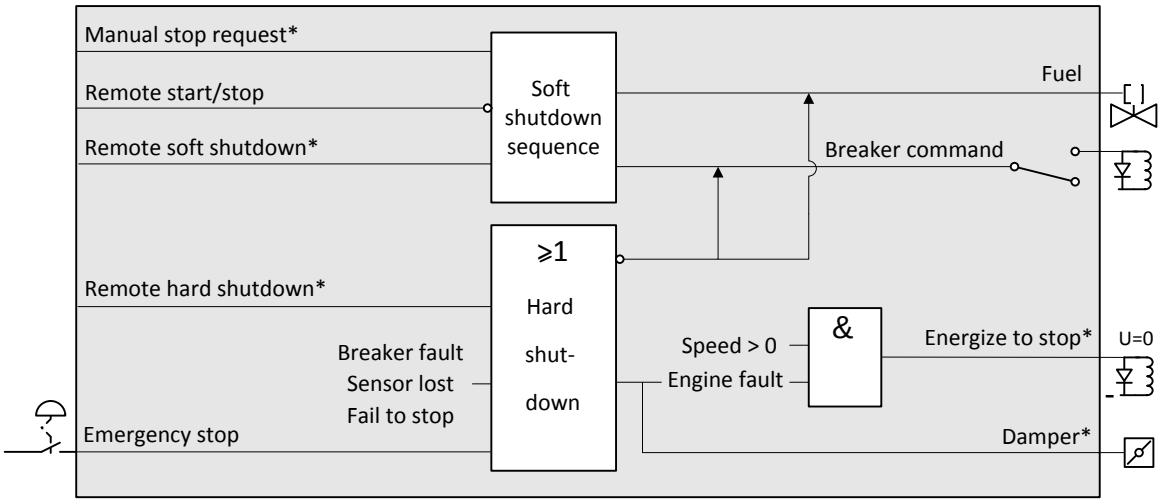
3.2.6 Stop and faults

On manual request (local or remote), GENSYS executes a sequence to open the breaker and cool the engine down (soft shutdown); the succeeding states can be followed in the Information page.

In event of a major fault, GENSYS immediately (hard shutdown) opens the breaker and stops the fuel.

Any other internal protection can trigger either process through assignment of an action, provided an output is preset, is connected and feeds back the related remote shutdown input; for more details, refer to the section *Protections*.

The various potential external events show on the following diagram:



* Assignment of a direct or remote digital input or output in CRE Config

If the relay has to be energized to stop the generator, use the output “Energize to stop”. GENSYS stops the air feeding (Damper output) if the proper digital output is connected and preset to Damper function.

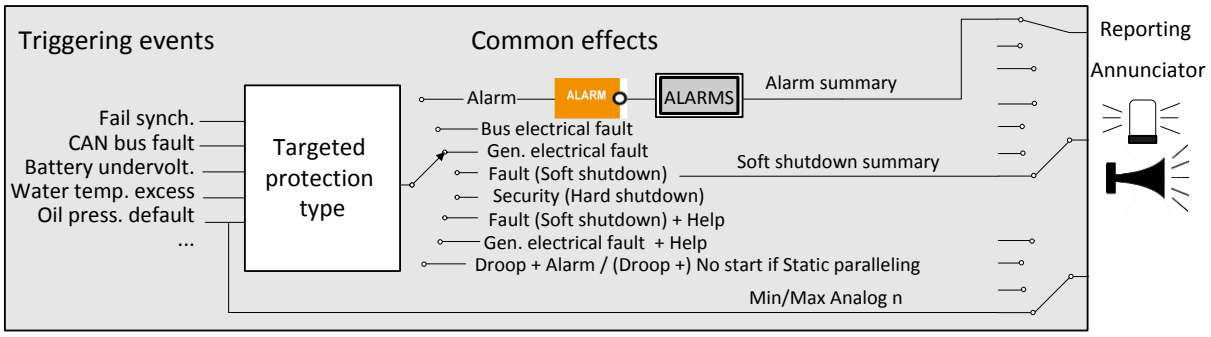
3.3 PROTECTIONS

3.3.1 General

Protections are triggered by internal and external events (alarms, faults, digital inputs, CAN bus loss, …). To protect the process, the engine or the alternator, you must associate one of the predefined actions to each such event. These actions or effects are of various kinds:

- they can just raise an alarm; notice shows on the front panel (ANSI30); a summary can be reported
- they can secure the equipment: the engine stops, the breaker trips safe … and can activate a free protective digital output
- they can invoke a fallback plan (reconfiguration).

The action is an attribute of the protection: CT settings, or of inter-module CAN bus loss : fallback setting. The Droop effect and value 10 are reserved to CAN bus fault (prefer 8 or 9 to have some load sharing).

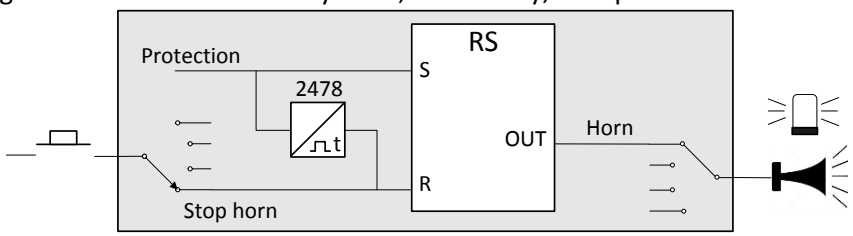


Value	Kind	Action	Description
0	–	Disable (no action)	–
1	Fallback	Generator electrical fault	The protection opens generator breaker and tries to re-synchronize again. Count of attempts set by 4854
2	Fallback	Bus electrical fault	Usual trigger: frequency/voltage out of range
3	Alarm	Alarm	Notice as alarm on front panel
4	Security	Fault (Soft shutdown)	Generator breaker opens allowing the engine to cool down off load for the duration of the cool down timer, then stop
5	Security	Security (Hard shutdown)	Generator breaker opens and engine stops immediately without cooling down; “Serious fault” shows as information
6	Fallback	Fault (Soft shutdown) + Help	See chapter *Fallback plans*
7	Fallback	Gen. electrical fault + Help	*ibidem*
8	Fallback	Droop + Alarm	*ibidem*
9	Fallback	Droop + No start if Static paralleling	If already started, the generator runs on; otherwise, no
10	Degraded	No start if Static paralleling	*ibidem*

The actions are configured in CRE Config. Numerical values 0…10 show only in text file. See *8.2, p.102*.

3.3.2 Audio or visual annunciator

To trigger an external annunciator whenever a protection trips, connect it to an output preset to the Horn function; the signal duration is modified by 2478; alternately, an input can be used for remote reset:



Setting	Label	Description
2478	Horn delay	Duration of ring. Default value: 10s. 0 means the horn will buzz until being manually stopped

3.3.3 Call for help

A help protection calls another engine for help and contributes to a summary (Soft shutdown or GE electrical fault). See *Fallback plans*.

3.3.4 Emergency stop

The emergency stop function can be done in two ways:

- Connecting a normally closed “mushroom-type” button to the digital input “Emergency stop”. This is a pure software solution.
- Hard-wired solution, where the button also disconnects power supply from the controller outputs like Fuel and Crank.

Note: In case of many cranks, don’t forget to disconnect all cranks

3.4 POTENTIAL ALARMS/FAULTS CATALOG

The potential alarms/faults are listed below.

- Potential Alarm/Fault: Alarm/Fault label; this text shows in the Alarm/fault pages
- Action on alarm/on fault: this variable allows you to define the associated protection type (8 potential values; target to which the signal contributes)

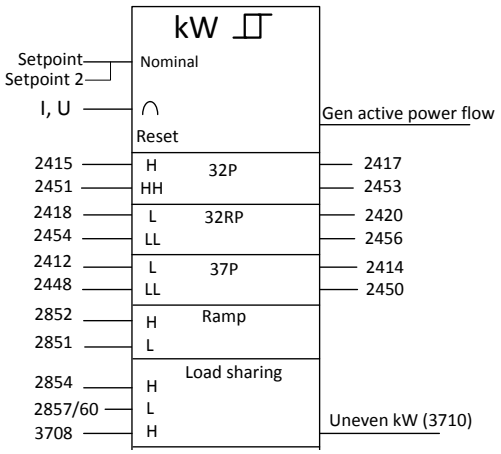
This list can be downloaded from CRE Config/System/PC transmit-receive/Action on alarm/fault".

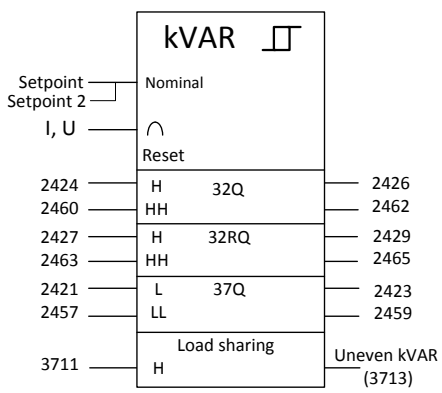
ELECTRICAL (all trip after a definite time, except Short circuit which trips after an IDMT; see Appendix):

Potential Alarms/Faults	ANSI	Description	On alarm	On fault
Overfrequency	81H	Generator is in over frequency	2402	2438
Underfrequency	81L	Generator is in under frequency	2405	2441
Undervoltage	27	Generator is in under voltage	2411	2447
Overvoltage	59	Generator is in over voltage	2408	2444
Min kVAR	37Q	Generator reached a minimum of kVAR	2423	2459
Max kVAR	32Q	Generator reached a maximum of kVAR	2426	2462
-kW	32RP	Generator is in reverse kW	2420	2456
-kVAR	32RQ	Generator is in reverse kVAR	2429	2465
Min kW	37P	Generator reached a minimum of kW	2414	2450
Max kW	32P	Generator reached a maximum of kW	2417	2453
Max I	50	Generator is in over current	2432 (I>)	2468 (I>>)
Max In	50N	Generator is in over neutral current	2435 (I0>)	2471 (I0>>)
Short circuit	51	Short circuit between generator phases	–	2477
Over speed	12	Engine is in over speed	2352	2370
Phase measure	–	Generator voltage measurement is inconsistent with configuration [2003]	2805	–
Breaker fault*	Includes 50BF	A fault is triggered if the breaker does'nt send proper feedback	–	Hard shutdown
Breaker alarm*		An alarm is triggered if the generator breaker controls do not work correctly	Alarm	–
Fail to synch	25	The unit cannot synchronize to Bus	2804	
Uneven kW	90P	See *4.4.1, p.45*	3710	–
Uneven kVAR	90Q	*ibidem*	3713	–

* According to the state of the module, a breaker alarm or fault could appear. It could be a fail to close breaker, fail to open breaker or breaker open suddenly.

Summary with threshold codes (as they show in text file), output and action codes on alarm & fault:





Load shedding (Refer to 0, p.54):

Potential Alarms/Faults	Description	On alarm
Trip alarm	Generator is in under frequency in percent	3702
	Generator reached a maximum of kW in percent	3705
	All trip out	2862

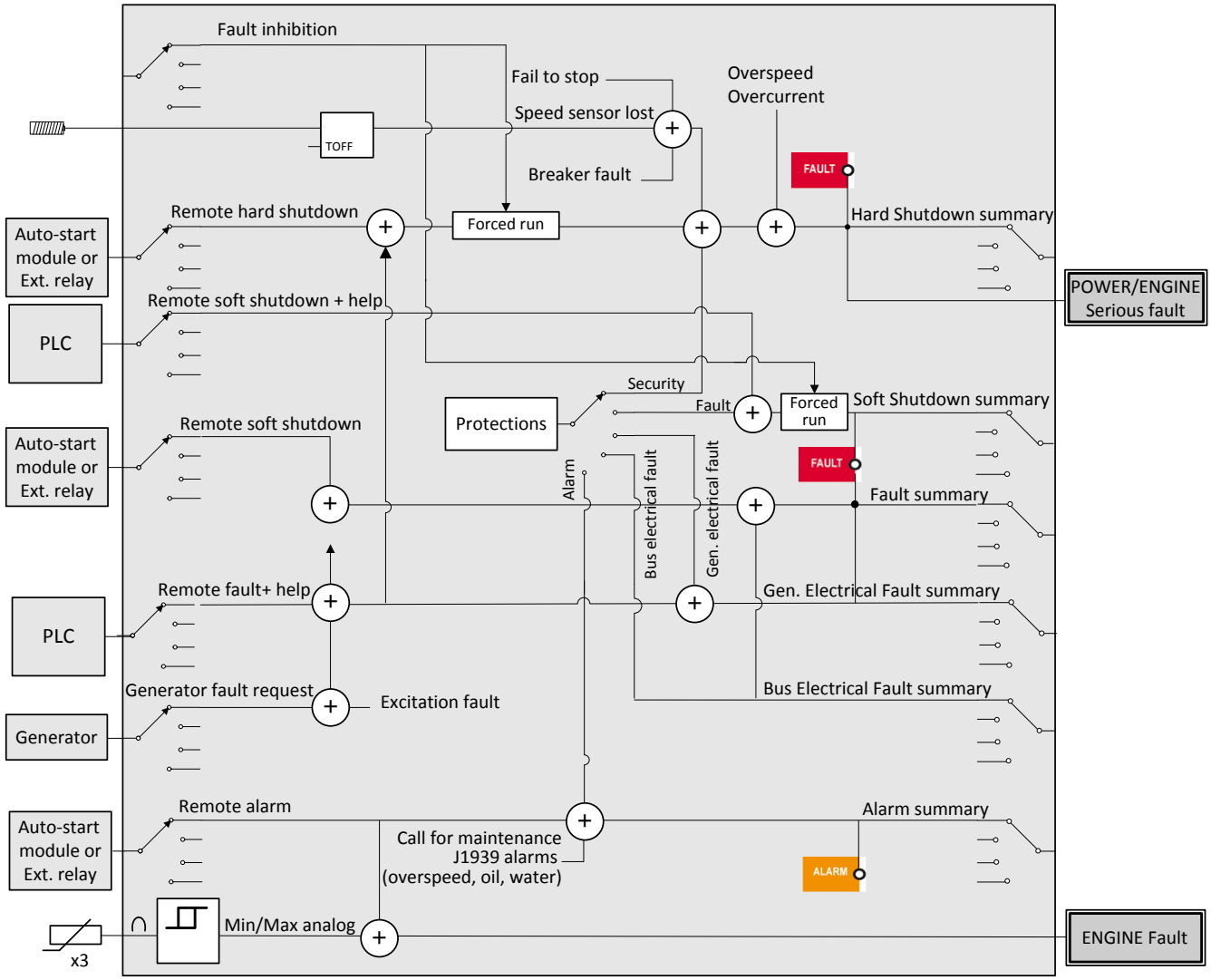
Others:

Potential Alarms/Faults	Description	On level 1/Min	On level 2/Max
Min oil pressure	Oil pressure under minimum	2364	2382
Max water	Max water temperature over maximum	2367	2385
Sensor lost	Triggered if the speed is 0 and engine has started		Hard shutdown
Fail to stop	Triggered when engine does not stop correctly		Hard shutdown
Not ready (1)	See the section *3.2.1, p. 27*		
Fail to start	*ibidem*		
Min battery voltage	To set the thresholds, refer to E*, p.76*	2358	2376
Max battery voltage	*idem*	2361	2379
CAN1 bus fault	Communication problem on the inter-unit CAN	3052	–
CAN2 bus fault	A J1939/CANopen bus error is detected. See *7.3, p.94*	3053	–
Overspeed	(Extreme) Over-speed detected by J1939	3104	3105
Low Oil P	(Very) Low oil pressure detected by J1939	3108	3109
High Cool T	(Very) High water temperature detected by J1939	3106	3107
Malfunct lamp	See *7.3, p.94*	3110	
Protect lamp	*ibidem*	3111	
Amber lamp	*ibidem*	3112	
Red lamp	*ibidem*	3113	

(1) For an external start module, the alarm/fault [4473] Engine not ready corresponds to a loss of generator ready signal.

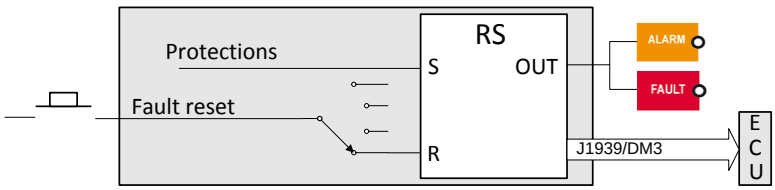
3.4.1 Synthesis

The faults and alarms are synthesized as follows. The specified action selection is depicted as a selector in the middle of the illustration. External relays can contribute to Generator protection.



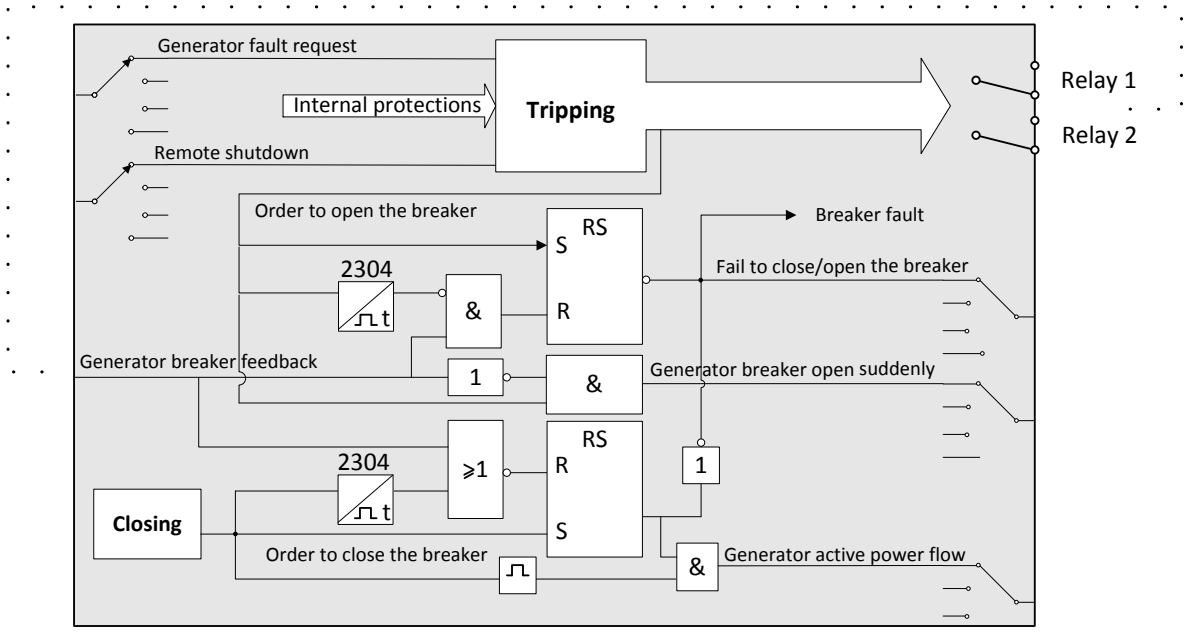
Fault inhibition (battle switch): refer to the *Appendix/Standards for generators/NF E37 312*.
Print & fill the table at the end of this manual; it will help determine the potential causes of a signal.

Clearing of faults/alarms:
- Locally: Shift + 
- Remotely: use the “Fault reset” input function



3.5 BREAKER MANAGEMENT

With the breaker feedback, failures and unexpected opening (ANSI94, ext. or manual) are signaled.
A time-out [2304] (5.0s by def.) precedes the signaling that the breaker has not opened/closed:



3.6 CYCLES BEFORE MAINTENANCE

You can program maintenance operations based on counts of cumulated running hours or days. Five cycles are based on running hours, five cycles are based on running days. The counters of the latter cycles are incremented every day whether the generator has run or not. In the frame of a maintenance program, they are used to call for various maintenance operations: the longer the running cycle, the deeper the generator inspection. The cycles usually imbricate in one another.
In CRE Config/Configuration/Maintenance or in the text file, set the cycle name and the duration:

Setting	Label by default	Description
3500 … 3509	Cycle x(h/d) or Meter x(h/d)	Cycle duration in running hours (h) or days (d); x=1 …5

The alarm name shown when the cycle is elapsed will be the label. The countdown of left hours/days since the latest reset can be read in CRE Config/Scada/Maintenance cycle monitoring or in "Display/Maintenance" ("off" means that the cycle is not defined). It is saved into non volatile memory.

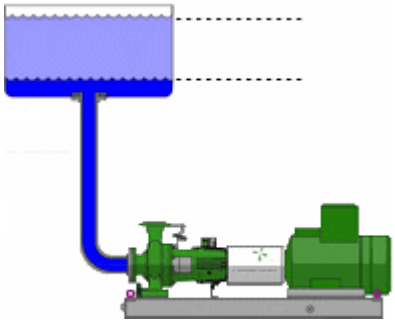
Reading	Label	Description
0850 … 0859	Maintenance (hours/days) n°x	Countdown in running hours (h) or days (d); x=1 …5

At any time, you can reset a counter in CRE Config/Config./Maintenance: press counter Reset button. When a cycle duration has expired, the corresponding alarm is raised. Read the alarm page to know which cycle has run out and reset the alarm. This resets also the counter of the corresponding cycle.

3.7 FILLINGS OF FLUIDS

3.7.1 Presetting

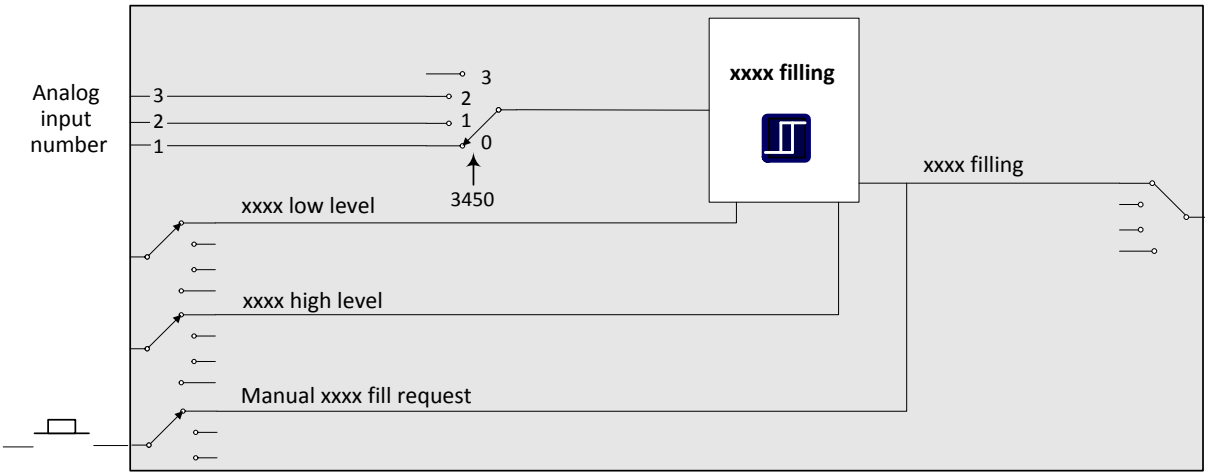
GENSYS can monitor the levels of fuel, oil or coolant while the generator is running. Each fluid monitoring requires either an analog resistive level sensor or two switches (one high level and one low level):



Using CRE Config/Configuration, preset as follows (say xxxx = fuel, oil or coolant).
Sensor 0…500Ω + settings:

- In “Filling”, preset an analog channel to a sensor input and set thresholds
- In “Inputs/Analog inputs”, calibrate the corresponding sensor

Switches: in “Inputs/Digital inputs”, preset 2 channels to xxxx low/high level.

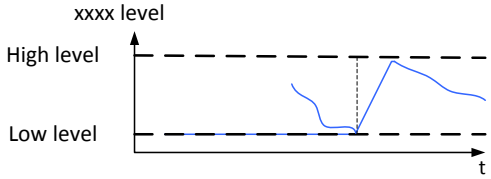


3.7.2 Filling up

In CRE Config/Outputs/Digital outputs, preset an output to the function xxxx Filling up (filling order).

Automatic mode

GENSYS autofills the tank when the low level is reached:

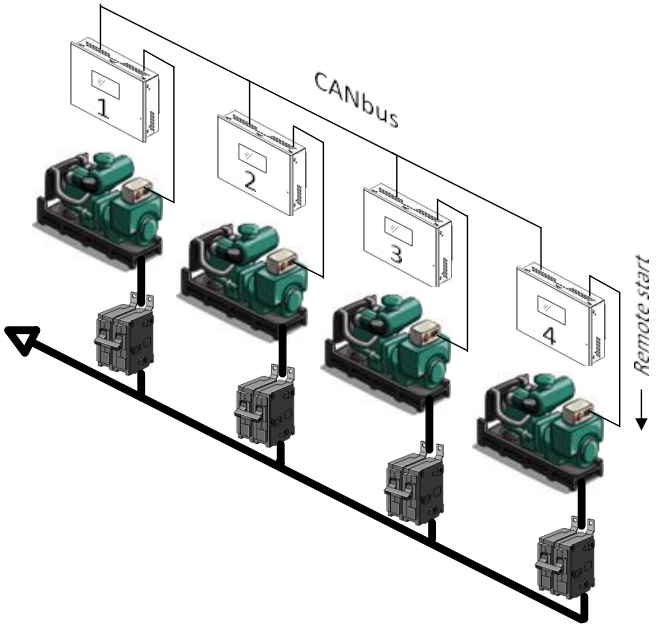


Manual mode

In “Digital inputs”, preset an input to the function Manual xxxx filling up request.
It is interconnected with the digital output preset to xxxx filling. After pressing **MAN**, press the external push-button till the desired level is reached (the upper threshold is not enforced).

4 APPLICATIONS

In island operation, each generator in the aggregate is controlled by a private GENSYS unit. All GENSYS units are CAN-connected. A typical configuration for paralleling is the following:



Starting from the default settings, just enter the installation:

Setting	Label	Value
2000	Count of gen.	1 ≤ N ≤ 32
2001	GE Number	1 to 32 (differs for each GENSYS on one bus)

The default settings are in bold:

Setting	Label	Value
2050	Paralleling mode	**Dynamic [0]**, Static [1]
2002	DeadBus manag.	No[0], **Yes [1]**
2850	Load/Unl. mode	**No [0]**. To change it, see section *4.4.3, p.49*

4.1 FIRST START

All the GENSYS units with an activated “Remote start” input start in AUTO mode. The fastest generator’s GENSYS makes sure that the bus bar is unpowered (dead bus bar), closes its breaker and takes the load.
The others synchronize with the bus bar.

Then, if [2850] = 0, all the generators remains on duty.
If [2850] = 1, 2 or 3, depending on the load demand, the aggregate decides which generators must stop. Messages are interchanged over the inter GENSYS CAN bus.
Calling a generator for production requires

1. An election based on load demand (see *4.4.3, p.49*)
2. The synchronization of the elected generator
3. A load ramp for soft transfer
4. A load sharing (kW/kVAR) according to the percent of load of each generator

4.2 SYNCHRONIZATION

4.2.1 Configuration

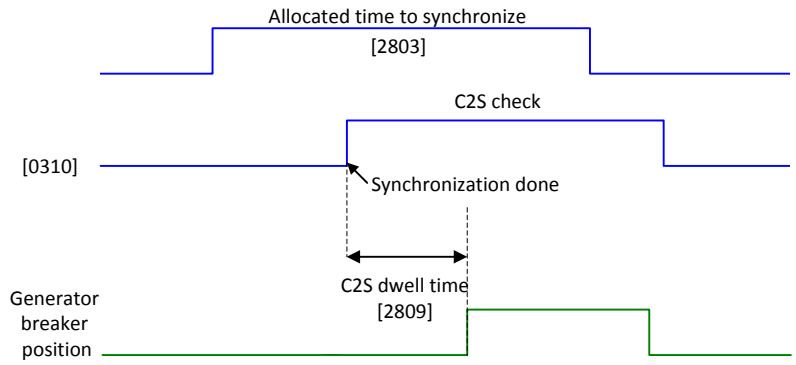
Various settings and readings are offered to control and follow the synchronization:

Setting	Label	Description	Default
2800	Voltage match	Max. difference (in % of nominal value) between generator & bus bar voltage for coupling	5%
2801	Freq. match	Max. frequency difference between generator and bus bar for coupling	0.1Hz
2802	Phase match	Max. phase angle difference between generator and bus bar for coupling	10°
2803	TM Fail sync	Allocated time to synchronize	200s
2809 (1)	C2S dwell time	Synchronization dwell time before authorizing to close the breaker	0.2s
Reading	Label	Description	
0306	Phase sequence	Phase sequence approve to close breaker	
0307	Voltage	Voltage gap approve to close breaker	
0308	Frequency	Frequency gap approve to close breaker	
0309	Phase	Phase gap approve to close breaker	
0310	C2S check OK	Synchroscope result	

(1) This parameter can be modified using TXT file or modification by variable number menu.

GENSYS launches the synchronization only if the bus bar features at least 80% of nominal voltage. The bus bar frequency and voltage are the set points of loop controls. When the generator and bus bar match, GENSYS orders the breaker closing.

Time chart:



If synchronization fails: GENSYS stops the generator. Another GENSYS is elected if Load/Unl. mode is 1,2 or 3; the ensuing action can be configured as described in *3.3, p.34*:

Protection	Label	Values as action
Synchronization failure	CT Fail synch	Alarm [3] (by default), Soft shutdown [4], Hard shutdown [5] etc

4.2.2 Tuning

Prerequisite: the outputs Speed & AVR are scaled to match the generator. See5.2*, p.60* and *5.3, p.62*. Settings are settable in “Configuration/ Synchronization”.

Setting	Label	Description	Default
	Voltage		
2951	P	Proportional	50
2952	I	Integral	20
	Frequency		
2901	P	Proportional	5
2902	I	Integral	20
	Phase - Angle		
2905	P	Proportional	70

Tuning process:

1. A generator has already started and its breaker is closed
2. Unplug the new generator’s breaker connector
3. Start this generator and go to “Display/Synchronization”
4. The generator synchronizes within 5s; otherwise, isolate the root cause (Voltage, frequency or phase) and adjust:
    - In a first time, the proportional in order to be closer of the set point
    - In a second time (if need), the integral in order to faster reach the set point

4.3 LOADING AND UNLOADING RAMP

4.3.1 Configuration

After a synchronization, GENSYS ramps up the generator load (soft transfer) to avoid overload or an abrupt load kick (hard transfer):

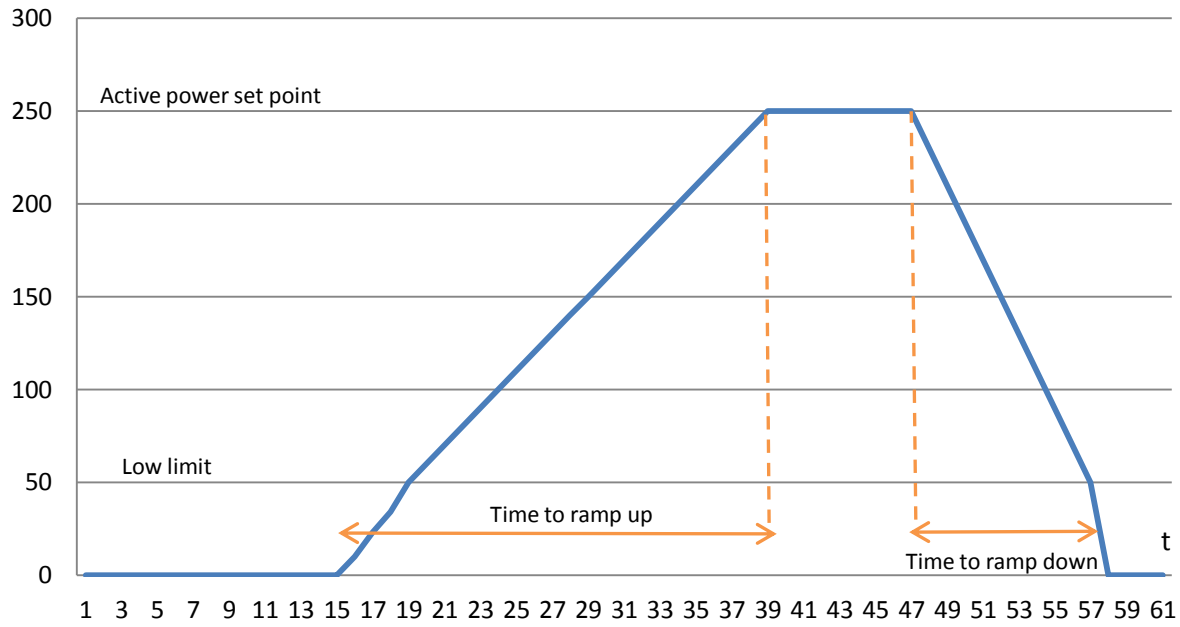
1. GENSYS calculates the average active and reactive powers from the information conveyed by the Inter-GENSYS CAN bus
2. It starts a load ramp to reach progressively these values (kW and kVAR regulations).

In the same way, when GENSYS must stop, an unload ramp is done.

Various settings are used in ramping up/down:

Setting	Label	Default	Description	Example
2851	Gen low lim	10kW	Wattage lower limit	50kW
2853	Loading ramp time	10.0s	Time to ramp up power from 0 to nominal power	50s (slope: 10kW/s)
2856	Unloading ramp time	10.0s	Time to ramp down power from nominal power to 0	22s (slope: 23kW/s)

Example: Nominal power = 500kW



Before isolating and stopping a generator, its GENSYS unit decreases its load from the current value to the low limit, where it opens the breaker, and the load drops to 0.

If a breaker fails to open at the end of an unload ramp, the generator continues to share the load as described further. GENSYS raises a breaker fault.

4.3.2 Tuning

Prerequisite: the outputs Speed out and AVR out are scaled to match the generator. See 0, p.60 and 5.3, p.62.

If the generator is in reverse power or does not takes enough load, set P in menu “Configuration/ control loop /Ramp kW or kVAR” (0 … 200%).

Note: On LCD screen, you can visualize during the ramp, the kW/kVAR setpoint and the kW/kVAR measure.

Setting	Label	Description	Default
2913	Ramp kW P	Proportional of kW ramp	100
2967	Ramp kVAR P	Proportional of kVAR ramp	100

4.4 POWER MANAGEMENT

4.4.1 Load sharing

GENSYS is informed of the other generators' loads through the CAN bus; they share the load in proportion to their power rating. This strategy is more reliable and accurate than an analog solution.

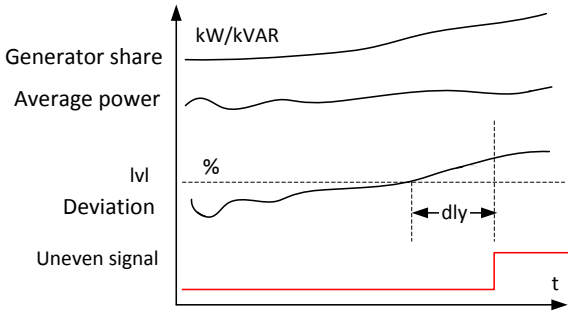
The **speed** control is used to share the **active** load. The **AVR** control is used to share the **reactive** load. Various readings are available:

Label	Description
kW GEx	Percent of nominal active power supplied by each generator (variables 400 to 431)
kVAR GEx	Percent of nominal reactive power supplied by each generator (variables 465 to 496)
Nom kW GEx	Nominal active power supplied by each generator (variables 433 to 464)
Nom kVAR GEx	Nominal reactive power supplied by each generator (variables 498 to 529)

The shares taken by the generators are monitored on CRE Config or LCD screen.

The relative deviation is (Generator share – Average load) / Average load. When it exceeds a threshold for a given time, a fault is raised if set.

Setting	Label	Description
3708	Uneven kW lvl	Threshold (in %) for the generator active power
3709	Unev. kW delay	Delay before raising fault
3711	Unev. kVAR lvl	Threshold (in %) for the generator reactive power
3712	Unev. kVAR dly	Delay before raising fault



The statuses and actions on alarm are as follows (the potential actions are listed in the chapter *Operation/Protections*):

Status	Label	On alarm	Description
4263	Uneven kW	3710	Generator active power is far from the average of all active powers
4264	Uneven kVAR	3713	Generator reactive power is far from the average of all reactive powers

If a GENSYS unit does not send any more frames on the inter-GENSYS CAN bus, all the generators are forced to start and take a load in a natural manner.
To withdraw GENSYS units from CAN bus communication, use either method:

- set the digital input Inhibit GEn [4557 … 4588] to 1
- change the variable [4557 … 4588] via Modbus TCP

To disconnect a GENSYS unit from the inter-GENSYS CAN bus, you must change the count of generators on all the other GENSYS units.

TUNING

Prerequisites:

- The outputs Speed out & AVR out are scaled to match the generator (*0, p.60* & *5.3, p.62*).
- At least two generators are synchronized.

	Factor	Setting	Label	Default
kW sharing	P	2917	Load sharing P	20
	I	2918	Load sharing I	1
kVAR sharing	P	2959	Share Q P	20
	I	2960	Share Q I	1

Once the setting of synchronization and ramp has been done, you can adjust the load sharing. kW and kVAR share stays within 2% of that power plant average.

Note : The kW/kVAR power plant average in % as well as the kW/kVAR of the genset in % can be visualized on the LCD screen during the configuration of the PID

You can change :

- Proportionnal : to decrease the correction time le temps de correction
- Integral : to decrease load sharing difference

Note : Integral is used only if the frequency/voltage centering is set (see 4.4.4).

4.4.2 Fallback plans

On events such as fault, CAN bus loss, forced substitution, each GENSYS can invoke a plan to recover or downgrade the load sharing. Generally one plan is adopted across the aggregate (setting 3052). These plans are a subset of the actions that can be enforced when a protection trips (refer *to 3.3, p.34*):

Protection	Plan	Description
1	Generator electrical fault	The protection opens generator breaker and tries to re-synchronize
6	Fault (Soft shutdown)+ Help	GENSYS calls another generator on duty via the CAN bus GENSYS waits till the backup is connected to the bus bar GENSYS opens its generator breaker, lets the engine cool down off load for the duration of the cool down timer, then stops the engine
7	Generator elec. fault + Help	GENSYS calls another generator on duty via the CAN bus GENSYS waits till the backup is connected to the bus bar GENSYS opens the breaker and tries again to synchronize. See previous section
8	Droop + Alarm	Only available for [3052] i.e. in event of CAN bus loss
9	Droop + No start if Static paralleling	Idem (CAN inter-GENSYS only)
10	No start if Static paralleling	Idem (CAN inter-GENSYS only)

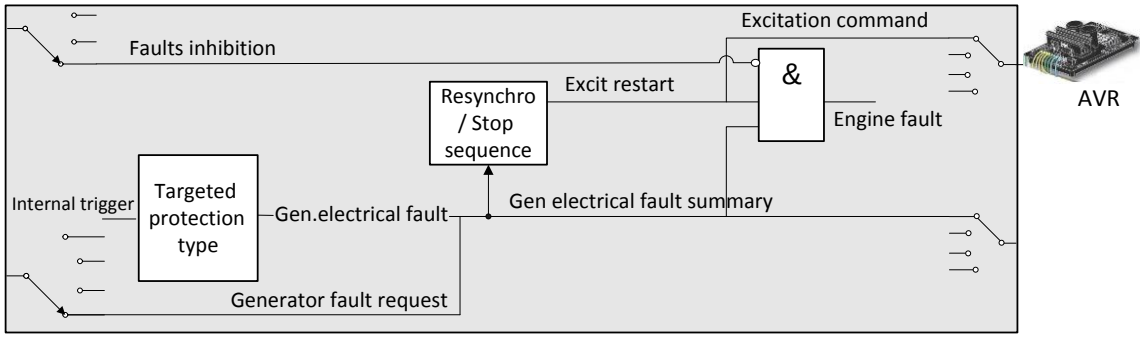
In static paralleling (Parall. mode = 1, see *4.5.1*), the effect of 9 -10 depends on when CAN bus is lost:

Abortion (9 or 10)	Droop (9) or No load sharing at all (10)
Start	Load sharing

NO generator can start as their AVR never gets the information on when to send the excitation order.

Resynchronization after generator electrical fault

A fault detected by GENSYS and associated to Gen. electrical fault can raise such a fault; it can also be raised from outside (Generator fault request):

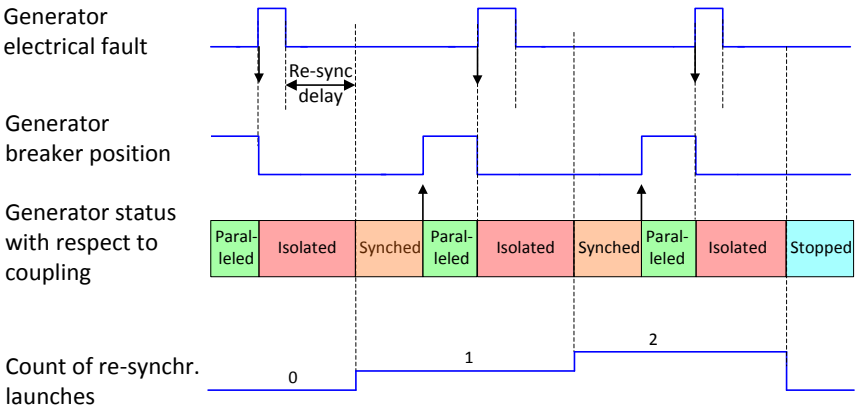


In event of a generator electrical fault:

1. GENSYS opens the generator breaker and restarts the alternator excitation (if connected) during the time [2052]; as long as Excit restart is activated, Engine fault is raised
2. If the fault is still present at expiry of [2051], GENSYS commands a hard shutdown (and Engine fault is raised again, see *3.2.6, p.33*). Otherwise GENSYS attempts to re-synchronize

Setting	Label	Default value	Description
2052	Excit. rest	10.0s	Excitation stop time after electric generator fault
2051	TM max. excit	10.0s	Timeout for excitation
2806	Re-sync delay	30.0s	Delay before the GENSYS attempts to re-synchronize with bus bar
2807	Nb re-synch.	3	Maximum count of re-synchronization launches before forced stop
2808	TM reset synch	30.0s	Time to reset the count of re-synchronizations

Example with [2807] = 2:



Droop

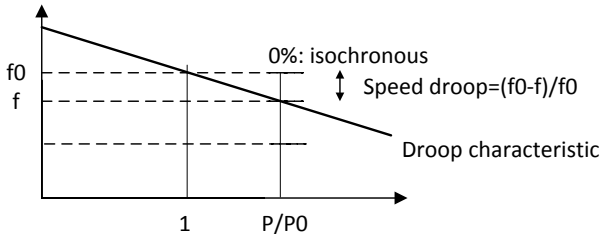
In event of CAN loss, speed droop and voltage droop are allowed to share kW load and kVAR load respectively. As droop is allowed, the control does not use any integral.

Frequency droop

The droop is the allowed relative offset:

Speed Droop = (Rated no-load frequency – Base frequency)/ Rated no-load frequency

In the aggregate the generators were requested to run in proportion to their rated power i.e. with the same P/P0. As they are set with the same droop, they share the same droop characteristic. As the load demand increases, they respond to the fall in frequency by increasing their active power outputs simultaneously. The increase in the active power output counteracts the reduction in frequency. Thus they do not fight one another to control the load (no "hunting").



Voltage droop uses voltage in place of frequency

The droops are set in the GENSYS units, not in the ESGs/AVRs:

If 3052 is set to 8 or 9 on all the GENSYS units, all the generators fall back to speed and voltage droops. It matters that all the GENSYS units be set to the same relative deviations 2204 and 2250.

Setting	Label	Description
2204	Speed droop	% for active load sharing. Default value: 2%
2250	Voltage droop	% for reactive load sharing. Default value: 2%
3052	CAN bus fault	8 or 9
2306	TM base cl br	Delay to close breaker if [3052] = 8 . Default value: 15.0s

If the generators are not yet started, when they lose the CAN bus, a downgraded mode is enforced; the generator couplings are phased in: the generator #n cannot close its breaker before

[2306]/10 + 7 x n (seconds)

CAUTION

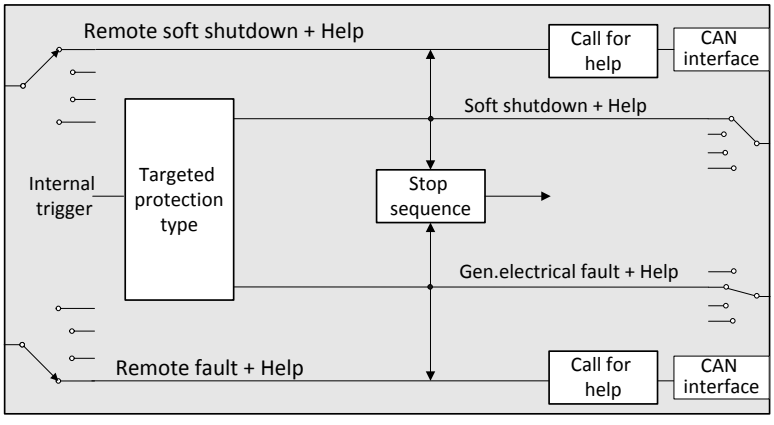
Follow strictly, throughout the aggregate, the scaling procedures (amplitude -offset) of chapter *Commissioning* in order to have the best load sharing in droop

Call for help

GENSYS can call for another generator to take over when an internally detected fault targets a protection of value 6 or 7 (refer to the chapter *3.3, p.34*). This can also result from the activation of a digital input preset to help (forced substitution).

The two offered functions/protection differ by the stop sequence (see protections 6 and 7):

- Soft shutdown + Help: GENSYS stops the engine after a cooling down delay
- GenElectricalFault + Help: NO cooling down delay



4.4.3 Load-dependent start/stop

Introduction

This function selectively phases the start and stop of the generators in an aggregate according to the current load. This prevents overload (you are advised to run generators between 70 and 85%). The CAN bus makes it possible to share load information & coordinate the actions.

Conditions required by automatic start/stop:

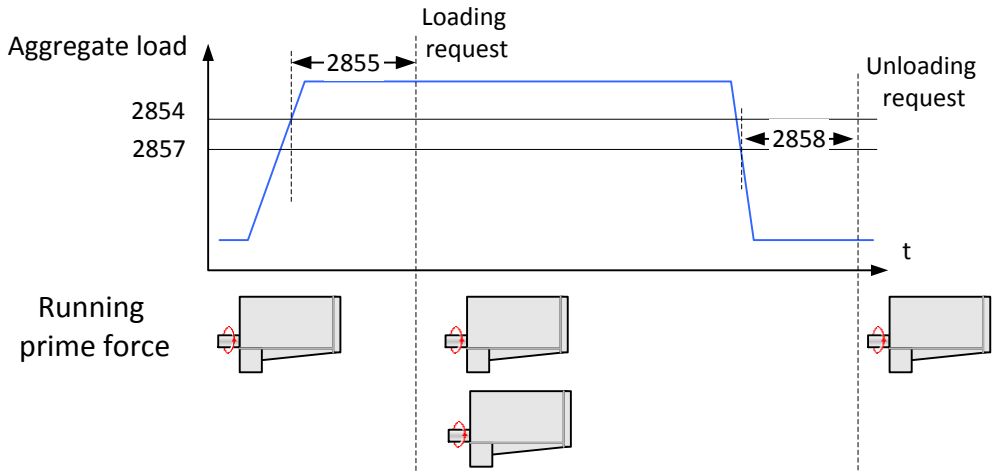
- The Remote start input must be permanently active on each GENSYS unit (i.e. connected to 0V); otherwise, the generator cannot start. This is the prime trigger
- At least 2 generators must be equipped with a GENSYS unit, all with identical LDSS settings
- All the GENSYS units must be in AUTO mode.

The settings are in CRE Config/Configuration/Power management system/LDSS.

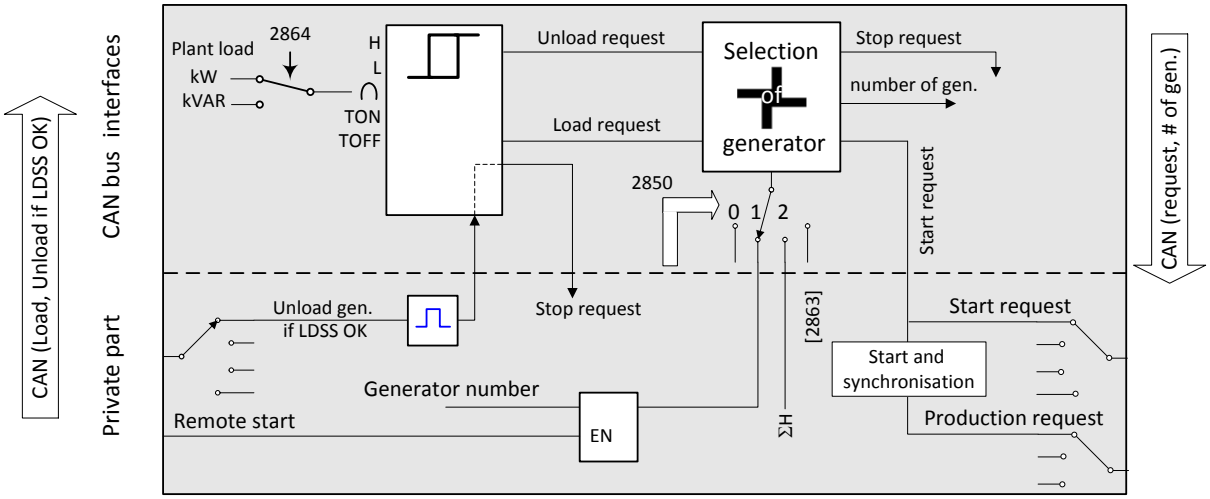
Principle

Each GENSYS unit is susceptible:

- To start its generator if the aggregate threshold 2854 has been exceeded during [2855]
- To stop its generator if the aggregate is under the threshold 2857 during [2858]:



This includes two stages in the CAN interfaces: decision to load/unload and generator selection:



A digital input preset to Unload gen if LDSS OK can be used to stop the related generator after checking that this will not overload the other generators. This input is latched. Unlike the inputs Fault+Help, it does NOT substitute the generator with another one. The GENSYS must NOT have been given priority by input. The generator restarts automatically.

Settings across the aggregate:

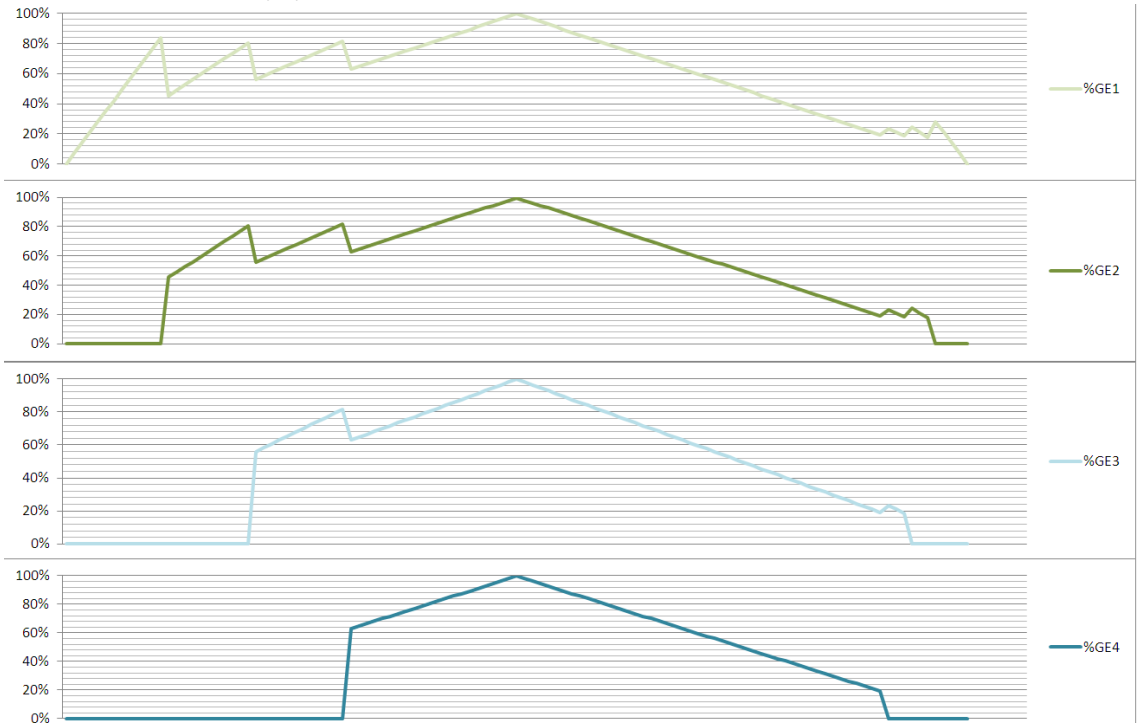
Setting	Label	Possible value	Description

2850	Load/Unl. mode	[0] Inhibited	No automatic start/stop of generators according to the aggregate load
		[1] GE number	Generators start/stop according to the Generator number
		[2] Hours run	Generators start/stop according to the GENSYS running hour meter
		[3] By custom	Generators start/stop according to my priority number [2863] (1 … 32)
2864	Load dep kVAR	[0] kW [1] kVAR	Base criterion: kind of power to assess
2854	LV Load thres	Default: 80%	Percent of load on the aggregate above which another generator is requested to start and share the load
2857	LV Unload	Default: 20%	Percent of load on the aggregate under which a generator is stopped
2855	TM before load	Default: 10.0s	Delay with power above threshold 2854 before GENSYS requests another generator to start and share load
2858	TM before unload	Default: 10.0s	Delay before deciding to reduce the count of running generators in load/unload management

Example:

A 4x100kW aggregate with a load that increases linearly from 0 to 400kW, then decreases to 0kW. Start threshold 2854 is set to 80% & the stop threshold 2857 is set to 20%.

Generator #1 is permanently running. When load increases above the start threshold, generator #2 starts to supplement generator #1, then generator #3 & generator #4 start. As the load decreases, the generators are phased out in the order 4, 3, 2.



Start-stop by generator number

If this way is selected on all GENSYS units in the power plant, the automatic start/stop phasing is based on the generator numbers, set in CRE Config/Configuration/Power [2001]:

1. The generator with the smallest number will start first and run onwards forcefully
2. On increasing load demand, the next starts are ruled by the generator number
3. On decreasing load demand, the generators are phased out in the reverse order.

Note: If a generator has been started forcefully in manual mode, it overrides the smallest generator number. It closes its breaker on the bus bar, even if there is no load (Dead bus management=Yes). The next generator to start is the one with the next smallest number.

Start-stop by running hours

In this way, the generator to start/stop is auto selected according to the GENSYS running hour meter:

- On increasing load demand, the next generator to start is the one with fewest running hours
- On decreasing load demand, the next generator to stop is the one with most running hours

Note: If a generator starts and goes past the hours run by a generator which is stopped, the first one does not immediately stop and the second one immediately starts. Coordination between generators is activated only on a load/unload request, i.e. in the next start/stop on-load request on the CAN bus.

Start-stop by generator priority number

If this way is selected on all GENSYS units in the power plant, the automatic start/stop phasing is based on the generator **priority** numbers, set in CRE Config/Configuration/Power manag system/LDSS [2863]:

1. The generator with the smallest number will start first and run onwards forcefully
2. On increasing load demand, the next starts are ruled by the generator priority number
3. On decreasing load demand, the generators are phased out in the reverse order.

Note: If a generator has been started forcefully in manual mode, it overrides the smallest priority number. It closes its breaker on the bus bar, even if there is no load (Dead bus management=Yes). The next generator to start is the one with the next smallest number.

4.4.4 Automatic frequency/voltage centering

Use cases

The secondary regulations (ESG and AVR) might drift, e.g. due to thermal variations.

To counteract these effects, a strategy called frequency centering is applied by default in the aggregate.

The same applies to voltage; the voltage centering can counteract a voltage drift.

When it is used to counteract the droop created by the ESG/AVR, this strategy is called “de-drooping”.

Settings

Settings across the aggregate:

Setting	Label	Description	Default value
2927	Hz center act	Activation	1 (enabled)
2926	Hz center gain	Central frequency gain of lead GENSYS	1
2970	U center act	Activation of central voltage	1 (enabled)

Procedure:

1. Adjust the generator speed to get 49Hz by tuning the speed governor offset
2. When the breaker is closed, the frequency must return to 50Hz within 5s
3. Adjust the Hz centering gain [2926] to adjust the time if needed
4. Adjust the generator speed to get 50Hz by tuning the speed governor offset
5. Repeat the steps for all generators
6. Test the load sharing by changing the nominal frequency of one generator to 49Hz.
   To do so:
   - Start a generator at 50Hz and close it breaker
   - Synchronize the generator at 49Hz
   - Check that the bus bar frequency comes back to 50Hz and the kW load sharing is correct

Note : load sharing integral is used only if the frequency/voltage centering is set.

Functioning

Using the CAN bus, the aggregate elects a leader among the generators on bus bar. The centering is applied only to the leader and requires no extra communications whether digital or analog.

For information, the leader number is indicated in [357] variable.

The centering is a slight proportional correction that slowly brings back the frequency and voltage to their nominal value. As a result, the leader takes more of the load. Through the load sharing loop of the other generators, the load balance is regained.

If the default tuning cannot counteract the drift, hone the tuning.

4.5 ADDITIONAL CAPABILITIES

4.5.1 Start by static paralleling

Use cases

- Starting a full plant with multiple generators in an emergency on dead bus: the generators are ready to take load in the shortest possible time, without warm-up
- Installation with a high voltage transformer: as the generators start, the transformer core is magnetized progressively, without peaks (no transient short-circuit).

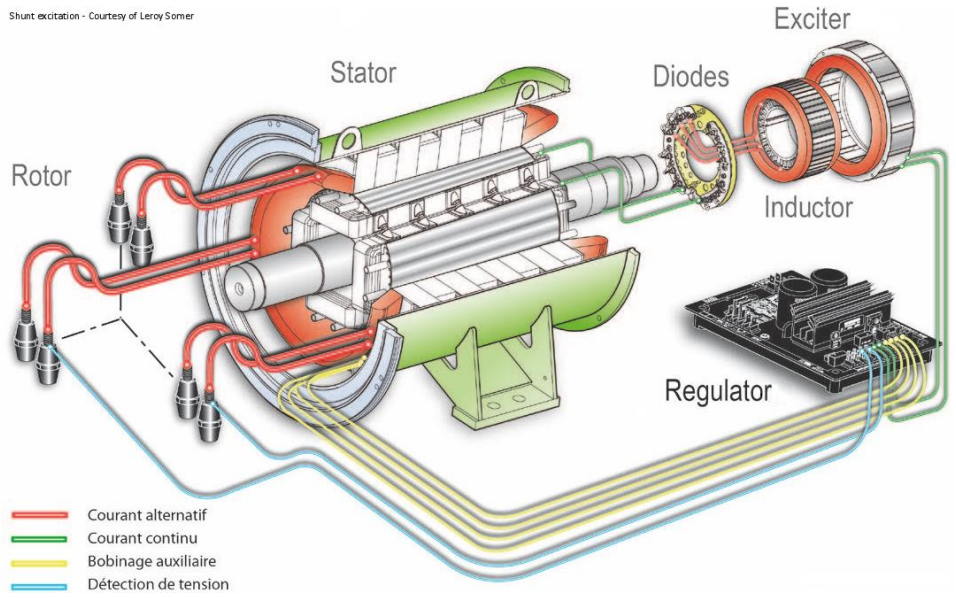
Conditions

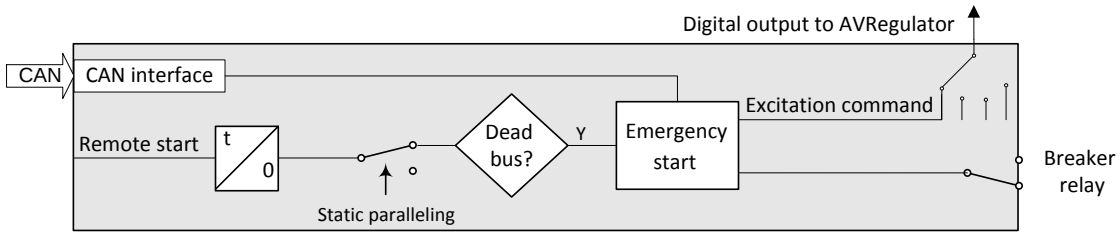
On equipment:

- The alternators are identical (in particular, same winding pitch)
- The AVRs are set for static paralleling: they wait for excitation command on their first start
- All breakers must be powered by continuous voltage like 24VDC (so as to close before AC is available)

On GENSYS:

- A digital input is preset to Remote start
- A digital output is preset to Excitation command

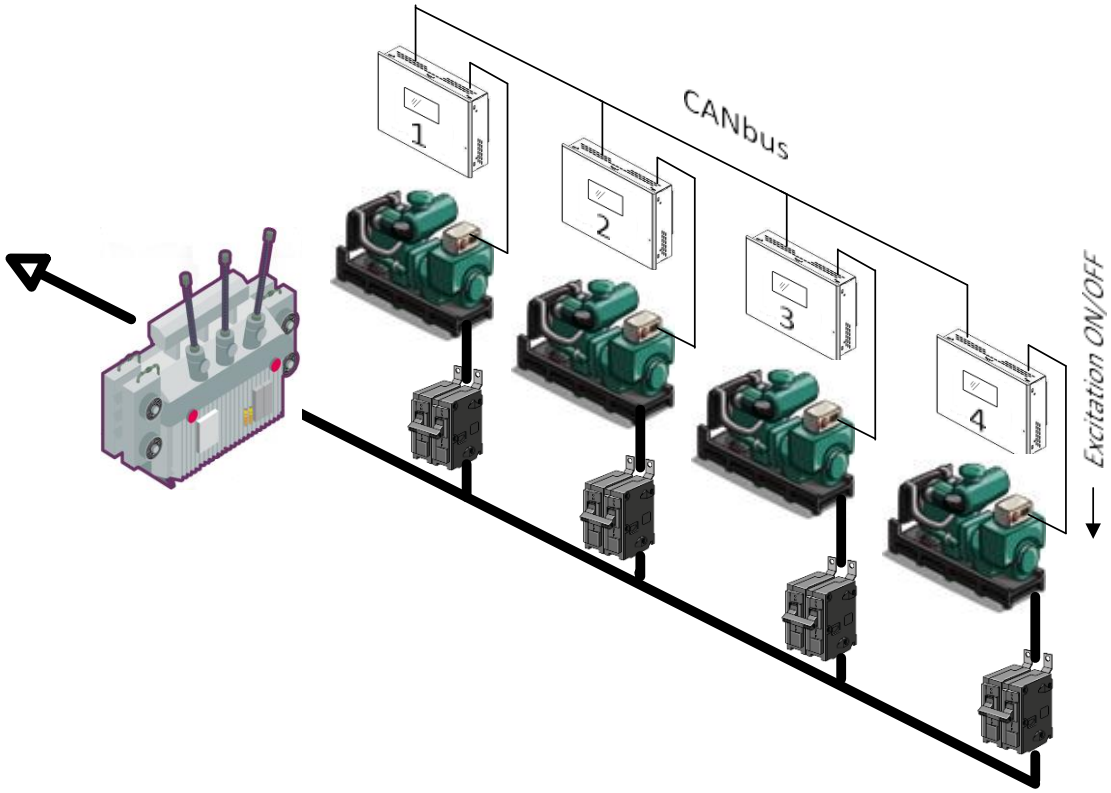


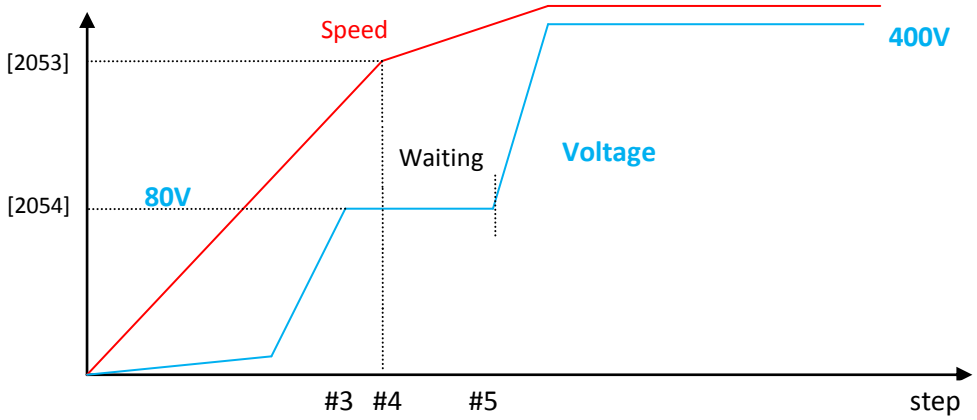


Setting	Label	Default	Description
2050	Paralleling mode	Dynamic	Static (to show the setting in CRE Config, tick Options>Advanced)
2051	TM max excit	10.0s	Timeout for excitation. This parameter must take care of the timer; prelubrication, preglow, starter, speed stabilization. See sequence further
2053	Excit. speed	90.0%	Speed low threshold in % of nominal speed before waiting excitation. Must be identical in all GENSYS units
2054	Excit. volt.	20.0%	Voltage high threshold in % of nominal voltage to validate closing breaker in static parrallel. It relates to the remanent voltage of the alternators. Must be identical in all GENSYS units

2056	TM Volt stab.	5.0s	Voltage stabilization timer after excitation order before to pronounce as engine ready. Must be identical in all GENSYS units. During this stabilization, the unit working in droop mode.

The generators are synchronized together through the CAN bus:





Sequence

1. Any signaling of bus voltage loss activates the Remote start inputs
2. All the GENSYS units close their breaker and start their engine
3. The remanent voltage appears
4. The fastest generator's speed reaches [2053]
5. The slowest generator's speed reaches [2053] before [2051] expires; then CAN bus orders all the GENSYS units to simultaneously activate their excitation output; as a result:

- the nominal voltage is reached immediately at the same time on all generators
- the plant can run at full capacity

Bottom line: full plant availability in less than 10s typically. This meets the NEC700 requirements.
As long as there is a voltage on the bus bar, the dynamic paralleling prevails even if static paralleling is configured.

4.5.2 Load shedding

Introduction

The load shedding is the ability to disconnect less important consumers if the aggregate is overloaded even when the full capacity is engaged; this prevents a blackout.
Any GENSYS – generally one – in the aggregate can take care of excessive demand. If the kW demand exceeds the aggregate capacity and/or the frequency has dropped below a threshold for a given time, the dedicated GENSYS unit activates outputs to shed non-essential loads.
Using two levels of thresholds and delays, you can setup your system to react more or less rapidly depending on the severity of the situation.

Settings

Setting	Label	Description	Default
3702	Under-freq valid.	Enables/disables under-frequency monitoring for load shedding	0
3700	Underfreq thresh1	1st level of under frequency monitoring	96.0%
3701	Underfreq thresh2	2nd level of under frequency monitoring (must be lower than level 1)	90.0%
3705	Max load valid.	Enables/disables overload monitoring for load shedding	0
3703	Max load thresh1	1st level of kW overload monitoring	95.0%
3704	Max load thresh2	2nd level of kW overload monitoring (must be higher than level 1)	100.0%
3706	Threshold1 delay	Delay for 1st level of control (kW and Hz)	6.0s
3707	Threshold2 delay	Delay for 2nd level of control (kW and Hz) (must be shorter than level 1)	2.0s
2861	TM trip out	Min. delay before shedding the next load	5.0s

They are set in CRE Config/Configuration/Power management system/Consumer functions; 2861 thru Modification. Using CRE Config/Configuration/Outputs, preset up to 5 outputs to x^{th} non-essential trip.
In the same manner as for protections, you can trigger an action when the shedding capacity runs out (a specific output Trip alarm is signaled if [2862] = 3):

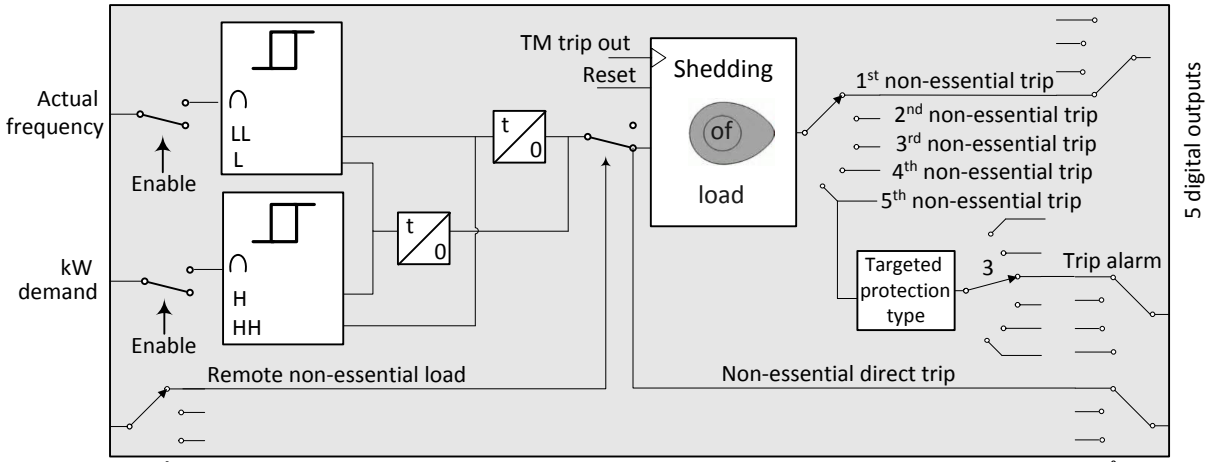
Setting	Label	Trigger	Values as action
2862	Last trip out	All non-essential loads are shed	0…7 (refer to chapter *3.3, p.34*)

Sequence

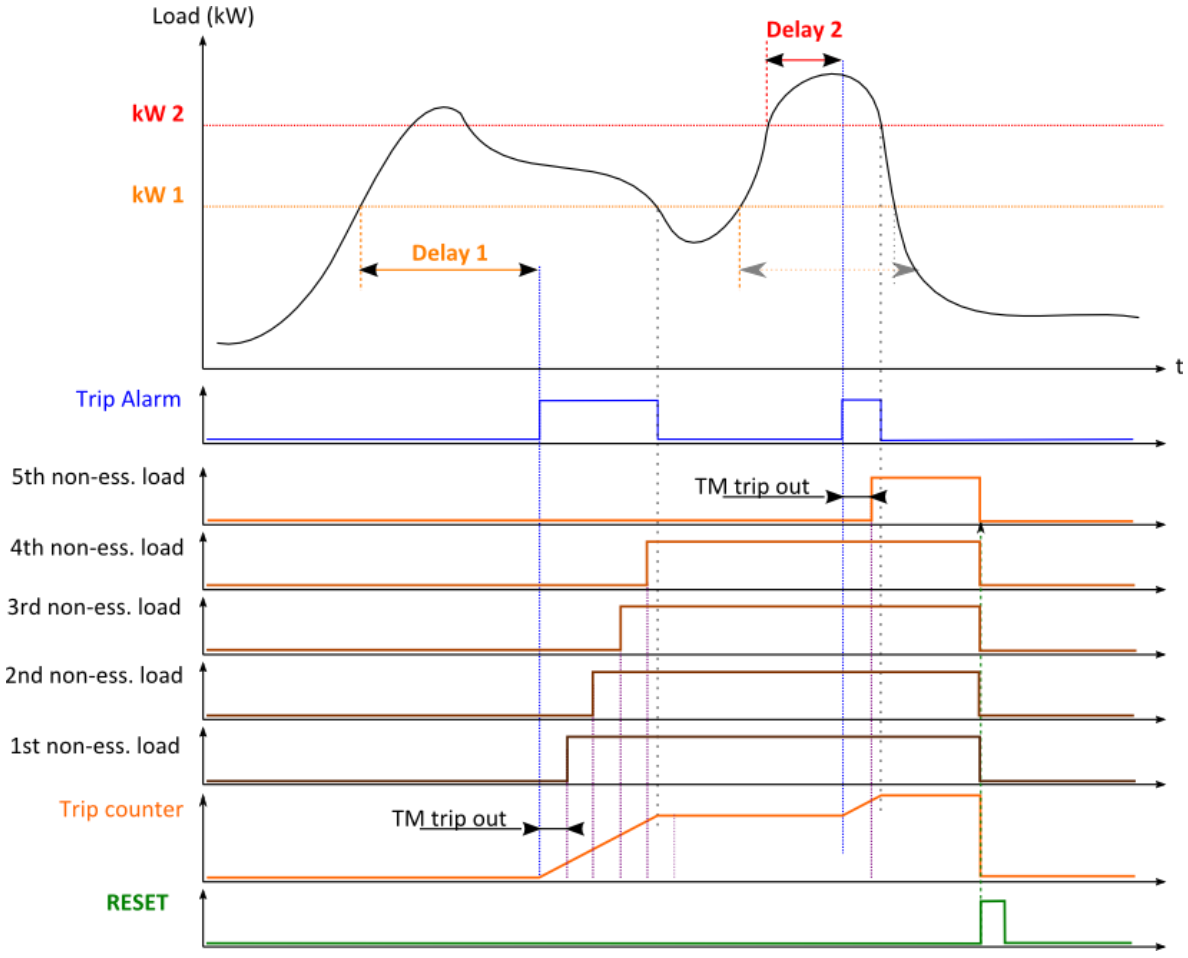
When one of the two levels is reached and its associated delay has expired, a trip alarm is set and a five-tier shedding starts (level 1) or escalates (level 2): at the end of a cycle based on 2861 an extra non-essential consumer is phased out till the threshold is reversely passed.

When the kW demand exceeds the supply, or when the frequency drops:

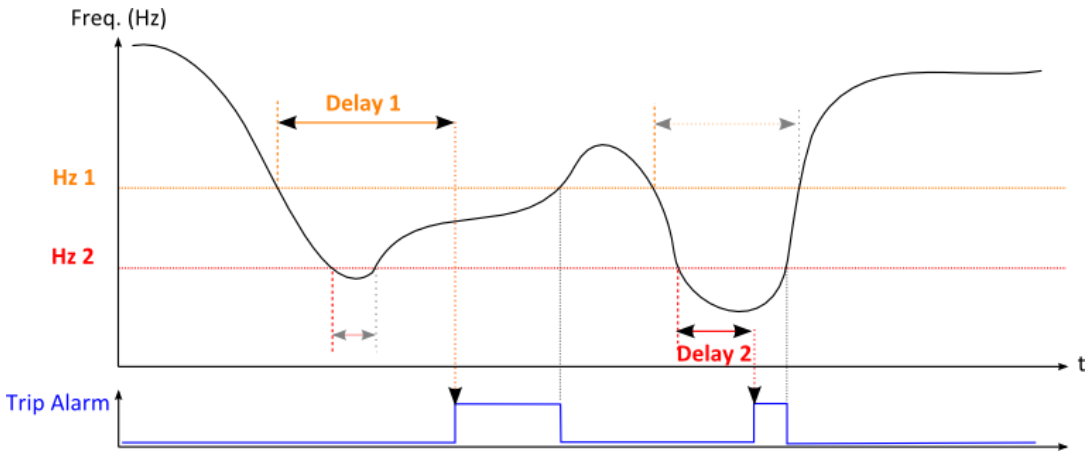
1. Trip alarm is raised after the related delay, as long as either threshold is trespassed
2. The Trip outputs are raised in a sequence after an extra delay; they are latched till a manual or automatic reset; it can raise an output preset to Non-essential direct trip



The next time charts show the trip alarm and trip outputs depending on the generator load or frequency.



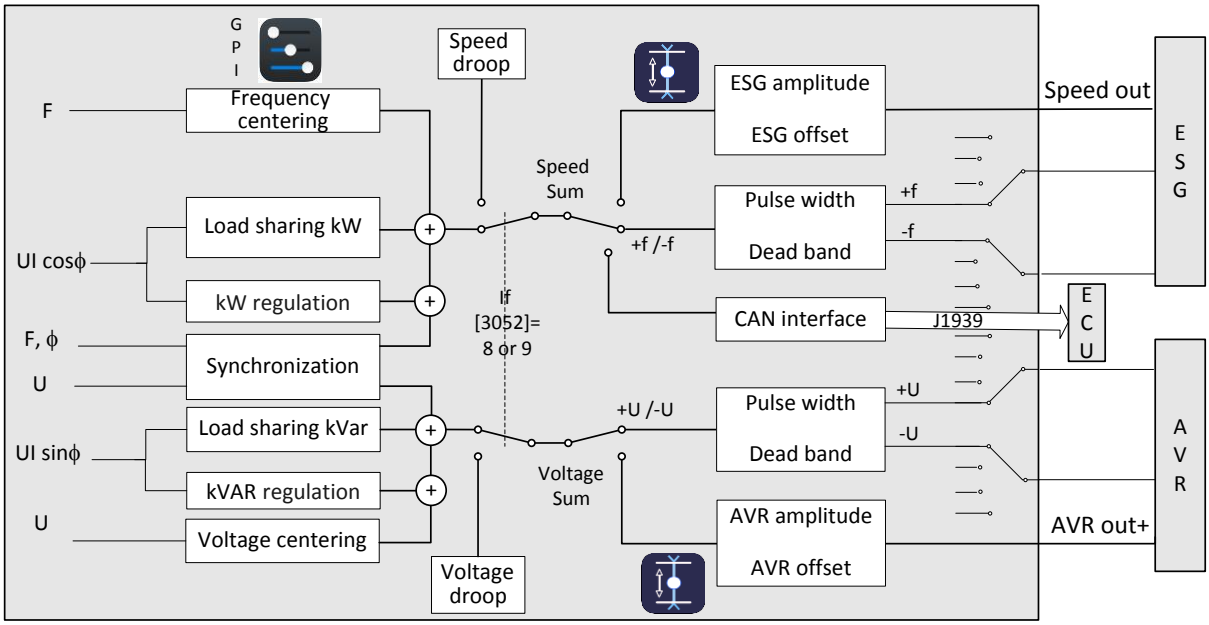
The trip counter sums the times during which at least one consumer is shed. It is reset at the same time as the alarm.


Freq. (Hz)
Delay 1
Hz 1
Hz 2
Delay 2
t
Trip Alarm

5 COMMISSIONING

5.1 INTRODUCTION

Each function produces a speed or voltage deviation based on its own GPI coefficients.
GENSYS feeds the sum of deviations to the output stage either as analog signals (Speed out and AVR out+) or as pulses train or J1939 frames (speed):



[4405] is the sum of all applicable speed deviations due to:

- Frequency and phase synchronization
- kW regulation (Load ramp)
- kW sharing
- frequency centering
- manual command
- speed droop (in event of CAN bus loss)

[4411] is the sum of all applicable voltage deviations due to:

- Volt synchronization
- kVAR regulation (Load ramp)
- kVAR sharing
- voltage centering
- manual command
- voltage droop (in event of CAN bus loss)

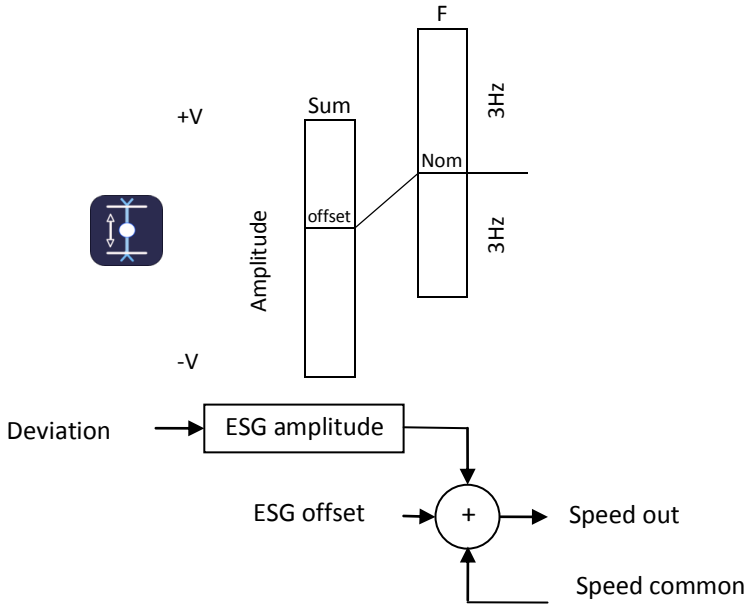
In fact, not all components contribute to the sum at one time; the sequencing is Synchronization->Ramp->Load sharing (+centering), and can be followed with

Reading	Label	Description
4009	Power mode	0: nothing 1: Synchronization 2: Droop 3: Load sharing
4010	AVR cont. mode	4: Ramp 5: Speed/Voltage constant (very transient)

CAUTION
Follow strictly, throughout the aggregate, the scaling procedures (amplitude -offset) to have the best synchronization, load sharing and droop

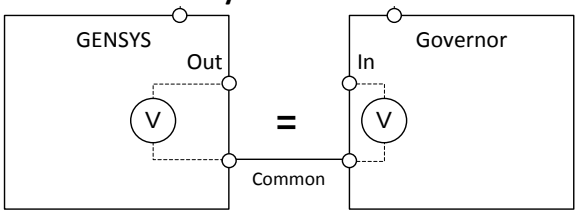
5.2 ANALOG SPEED GOVERNOR OUTPUT

The Speed output signal provides the set point for ESG, used in speed control, frequency synchronization and active load sharing. It is the sum of the components listed in the section *5.1, p.59*. The voltage range -10V …+10V must be fitted in amplitude and offset to allow GENSYS to vary the ESG set point on a correct range; the aim is that GENSYS can control the frequency in the +/-3Hz band around the nominal frequency:



Reminder: to change a setting, select it (black index), adjust it and press Enter.

1. Connect the speed **common wire only**



2. In “Configuration/Engine”, preset the amplitude and offset as described in the table further (if not listed, contact CRE Technology)

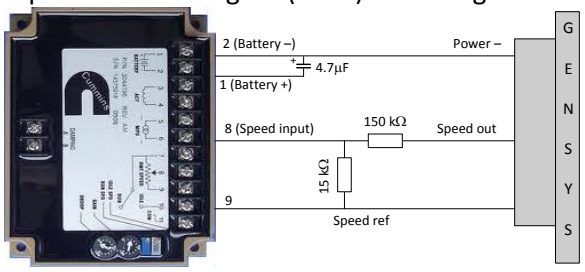
ESG amplitude	… V	
ESG offset	… V	
F	50Hz	Read-only
Engine Speed	1500	Read-only
Speed Sum	0000	

3. Trim the governor potentiometer to read 50Hz (or 60Hz)
4. Connect the Speed out signal; adjust the offset so that the frequency is 50Hz (or 60Hz)
5. Start the generator in manual mode by pressing **MAN** and **START** buttons
6. Adjust Speed sum to +100% with the **Shift** + ⮝ keys; adjust the amplitude so that the frequency is 53Hz
7. Return to 0%; adjust the offset if needed to get back 50Hz (or 60Hz)
8. Select the Speed Sum and adjust it to –100% with the **Shift** + ⮟ keys in order to check the variation range till 47Hz
9. Return to 0%;

The next table gives both settings for various ESGs. For other models, contact our Customer service.

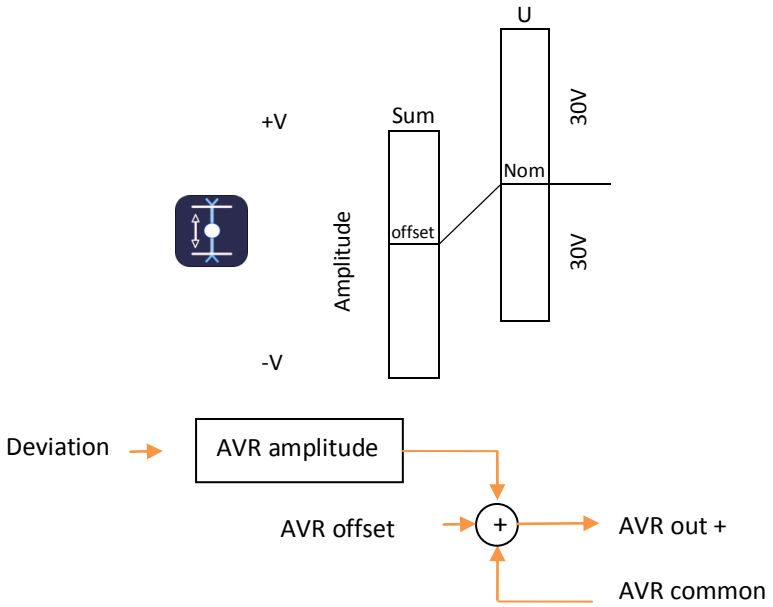
Manufacturer	Model	ESG ampl.	ESG offset	ESG input	ESG ref	Note
BARBER COLMAN	with analog input	0.5V	0V	ILS input	4V	
	DPG 2201	0.5V	0V	ILS signal	ILS+2.5V	The tuning depends on the connections
				ILS signal	Digital supply(+5V)	
				ILS signal	BAT-	
Cummins	ECM for QSK23 / QSK40 / QSK45 / QSX15 / QSK 60	2.5V	0V	11 (Barber Colman Freq. bias input)	06 (5V)	
	EFC	1.5V	0V	8	9	See schematic
	ECM (QST30)			18	15 (7,75V)	
DEUTZ FAHR	EMR	2V	2.5V	24	25	+/- 1.5 Hz not to reach EMR overspeed
GAC Governors America Corp.	ESD5330 All other ESD		–5V –5V	M N	G G	
GHANA CONTROL	PWC 2000			J	G	
HEINZMANN	E6 KG6 / System E6	2.5V	2.5V	B3 E3	A3	
	PANDAROS DC6	2V	2.5V	B3	A3	Voltage converter to isolate the signal on the line (DC/DC)
JOHN DEERE **LEVEL III**	JDEC	2V	2.5V	L G2	C 5V(ref speed) 999	Two different wirings for the same governor
mtu	MDEC	4V	0V	8	36 & 7 (5V)	
Perkins Marine Power	ECM 1300	2V	2.5V	30	5V	2 and 12 connected for external setting
VOLVO PENTA	EDC IV EDC III	1.5V	3V	Pot. signal		
WOODWARD	- 2301A/D ILS+speed - (Without U&I)	0V	3V	10 25	11 26	Shunt 14-16 Shunt 26 (com) on 0V
	2301D					G11 connected to 0V
	2301A Speed only EPG System P/N 8290-189 P/N 8290-184	4.5V 2.5V	2.5V 0V	15 11 (0.6V)	16 nc	16 connected to 0V Remove the shunt between 11 and 12

Because of the very high sensitivity of Cummins EFC module input, use the schematic below to connect GENSYS to the EFC. The resistors must be as close as possible to the speed governor terminal. This way, GENSYS analog speed output can be set higher (2205) according to the resistors used.



5.3 ANALOG AVR (AUTO VOLTAGE REGULATOR) CONTROL

The AVR out signal provides the set point for AVR, used in voltage control, voltage synchronization (U=U), reactive load sharing ... The components of AVR output are listed in the section *5.1, p.59*.
The voltage range -10V …+10V must be fitted in amplitude and offset to allow GENSYS to vary the AVR set point on a correct range; the aim is that GENSYS can control the voltage in the +/-30V band around the nominal voltage:



1. Connect the AVR **common wire only**
2. In "Configuration/Generator", preset the amplitude and offset as described in the table further

AVR amplitude	… V	
AVR offset	… V	
V1	230V	Read-only
U31	400V	Read-only
Voltage Sum	0000	

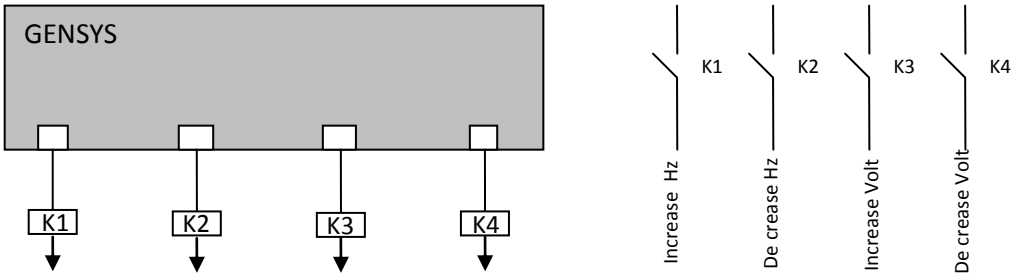
3. Trim the AVR potentiometer to read 400V
4. Connect the AVR out signal; adjust the offset so that the voltage is 400V
5. Start the generator in manual mode by pressing **MAN** and **START** buttons
6. Adjust Voltage Sum to +100% with the **Shift** + ⮝ keys; adjust the amplitude so that the voltage is 430V
7. Return to 0%; adjust the offset if needed to get back 400V
8. Adjust Voltage Sum to -100% with the **Shift** + ⮟ keys in order to check the variation range till 370V
9. Return to 0%

The next table gives both settings for various AVRs. For other models, contact our Customer service.

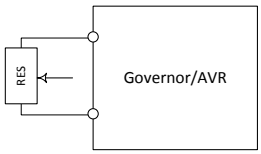
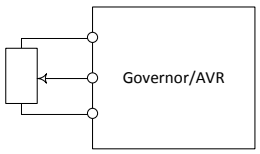
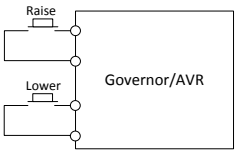
Manufacturer	Model	AVR ampl.	AVR offset	AVR out	AVR common	Comment
AEM ENGINEERED TO OUTPERFORM	R16		0V	8	Mid point of a resistive bridge betw. 7 & 9/10	See drawing
AvK	Cosimat N MA329	4.5V	4.5V	Mn A2(+)	n A1(-)	
Basler Electric	AEC63-7 AVC63-4(A)			6	7	Remove shunt between terminal 6 & 7 of the AVR
	AVC63-12	1.0V	0V	2	3	
	DECS32-15-xxx DECS63-15-xxx DECS125-15-xxx DECS300	Use VAR control included in the DECS				
CATERPILLAR	DVR KVAR/PF VR6 CDVR	 1.0V 4.5V	 0V 0V	7 3 P12.3	45 2 P12.6	
KIA Kato Motors C.a.	K65-12B K125-10B	1.0V	0V	2	3	
LEROY SOMER	D510	10V	0V	See drawings: AVRout feeds either analog input. 0…10V bias input provides a higher range of voltage bias control. AVR com is set to 5V		
	R230/448/449	1.0V	0V	Pot input +	Pot input –	Remove the shunt
	R610 3F	4.5V	0V	22	23	
marathon electric	DVR2010					
	DVR2000E	1.5V (±10%) 3V (±30%)	0V	A	B	
MarelliMotori	M40FA640A M40FA644A	0.35V 3.0V	0V 1.5V	8	6	
mecc alte spa	UVR6	2.0V	–4.5V	Pot +	Pot –	
sincro	FB			EXTPOT+	EXTPOT–	Trim potentiometer V of AVR fully counterclockwise. Remove shunt
STAMFORD	MX321			A1	A2	Trim potentiometer of AVR fully clockwise
	MX341			A1	A2	
	SX440			A1	A2	

5.4 SPEED/VOLTAGE CONTROLLED BY CONTACTS/PULSES

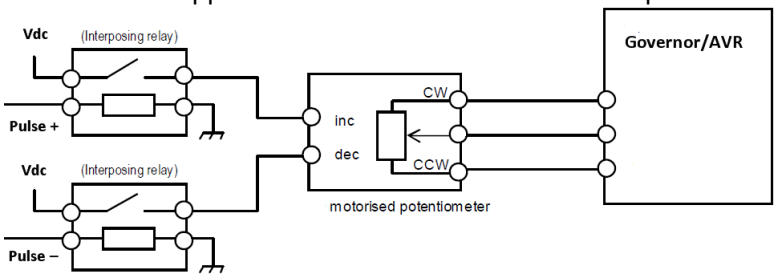
When digital outputs are connected to speed governor and/or AVR, the GENSYS PID controllers send speed/voltage increments/decrements by changing the state of these outputs:



Calibration device: various devices can be used depending on the governor/AVR.

Adjustable resistance	Manual potentiometer	Tapper (push-buttons)
		

A digital potentiometer, that converts the pulses into analog values, has its own settings: ΔU0 (fsd) & Time.
A motorized potentiometer: a stepper motor with a brake moves the tap



5.4.1 Setup

In "Configuration/Outputs/Digital outputs", assign to outputs a function Increase/Decrease speed/voltage by pulse.
Select the direction (output normally energized i.e. at state "1" or de-energized i.e. at state "0", refer to the chapter *8.3.2, p.107*).

As detailed in the section *5.1, p.59*,

- [4405] is the sum of all speed deviations (positive or negative)
- [4411] is the sum of all voltage deviations (positive or negative)

The dead band is the range (centered on 0) of them where no correction pulses are sent:

Speed		Voltage		
Setting	Label	Setting	Label	Description
3650	NonAction +f/-f	3651	NonAction +U/-U	Dead band: percent of [4405]/[4411]

Preliminary step:

1. Adjust the resistance at mid value or set the potentiometer tap in the mid position or the tapper in the mid position (unless the connection GENSYS-governor/AVR is direct)
2. Show the sum of all deviations [4405] / [4411]

The components of total deviation are split in two, as they are compensated in different ways. Finally, the compensations will be added.

5.4.2 Speed calibration procedure

- Set 3650 to 50% which is about 1 percent of deviation (dead band on 4405)
- Set 3652 to 2 which corresponds to a 200ms pulse width
- Remove the I component of the synchronization control: set 2906 and 2902 to 0

Note: To get the best results during synchronization, it's often useful to set the P values 2901 and 2905 high when tuning the synchronization (typical values from 80 to 200).

Setting for synchronization/load sharing

Extra setting:

Speed		Voltage		
Setting	Label	Setting	Label	Description
3652	Delay +f/-f Imp	3653	Delay +U/-U Imp	Pulse width

If the generator makes too much or not enough correction during an active phase (synchronization, load sharing…), it means that the pulse width is not properly adjusted:

- Decrease 3652 to reduce the pulse control on the governor
- Increase 3652 to have more correction on the governor

If the generator oscillates around the set point during an active phase or if it's hard to reach the set point, it means that the dead band 3650 is not properly adjusted:

- Decrease dead band 3650 to improve the accuracy around the set point
- Increase dead band 3650 if the generator oscillates in frequency or in load

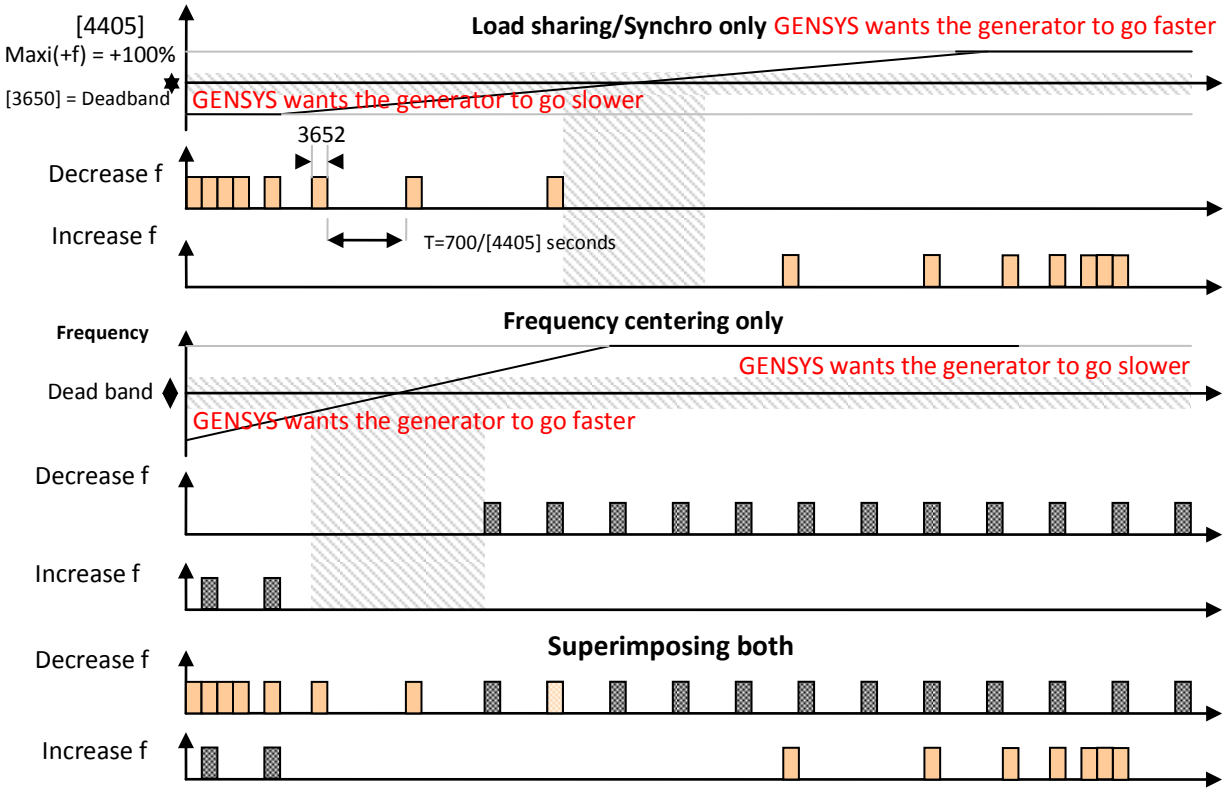
If there is a digital potentiometer between GENSYS and the speed governor, set ΔU0 (fsd) and Time; if you don't get the desired compensation, check the following points:

- Is the potentiometer still running when GENSYS sends an output signal?
- Check that the speed/voltage range controlled by the potentiometer is wide enough

Note: If pulses always generate an over-compensation, then it may be because the potentiometer is still running even after the GENSYS pulse is finished. In this case a shunt resistor on the potentiometer input may correct the problem by ensuring a proper low level at the input when GENSYS issues no pulse

Settings for frequency centering

1% of the deviation corresponds to dead band 47.5…52.5 Hz around 50Hz, e.g., a dead band of 0.1 Hz. If the generator changes its speed, but has compensated too much or not enough to reach the nominal speed, increase [3652] to increase the center frequency control.



5.4.3 Voltage calibration procedure

To calibrate the voltage control, execute the same procedure as the speed calibration procedure:

3651: Non-action range +U/-U (in %), default value = 0

3653: Delay +U/-U Imp, default value = 0

5.5 TESTS

Make sure that you have the latest power plant schematics and that all the cables (CAN bus, shielded cables, speed governor / GENSYS interface...) are ready. The HMI can be either LCD or CRE Config/Scada.

5.5.1 Individual check

Check up

1. Unplug the relay cable connector for safety purpose
2. Check the speed governor settings and AVR control settings
3. Check GENSYS settings according to the desired setup
4. Ask the technician who has wired the power plant to lock the generator breaker open
5. Check the fuel input
6. Check the battery voltage.

Check the protections

Make sure that at least these protections are properly set:

- Overspeed
- Overvoltage
- Oil pressure if available
- Water temperature if available
- Reverse kW

Start the generator

1. Start the generator in manual mode (**MAN**), and press **START**
2. Navigate to "Display/Inputs-outputs state /Digital outputs" where the states show in real time
3. If you want to simulate the sequences of starter & fuel switching, disconnect the related outputs
4. Check the activation of the starter (crank) and of the fuel pump
5. Check the generator readiness led is on
6. Check that the engine speed and the generator voltage are stable and adequate (e.g. 1500rpm, 50Hz, 400VAC); the data is available in “Display/Gen. electrical meter/Global view Gen.”
7. On the screen Engine/Generator, make sure the speed/voltage increases when pressing **Shift** + ⮝
8. Press STOP to stop the generator.

Check the control of the generator breaker on dead bus bar

1. Plug the relay cable and make sure the breaker feedback input is connected
2. Start the generator in manual mode (**MAN**), and press **START**
3. Press the generator breaker **0/I** button
4. Make sure the breaker closes (control OK displayed) and the Breaker status led lights up
5. Apply a dummy load (active and reactive) on the bus bar and check the powers, currents, volts
6. Press the generator breaker **0/I** button
7. Make sure the breaker opens and the led goes off.

5.5.2 Island mode check

When at least two GENSYS units have been successfully tested, check the island functions.

Check the synchronization

1. Unplug the Relay cable connector of the second generator GENSYS
2. Check the bus bar voltage and the bus bar led
3. Start the generator in manual mode (**MAN**), then press **START**
4. Press the generator breaker **0/I** button
5. Using the Information screen **[I]** button, check that GENSYS tries to synchronize
6. When there is no phase difference anymore (synchroscope at noon in "Display menu/Synchr."), check the phase sequence and check that all the voltages match upstream and downstream from the breaker. If a check is negative, check the wiring of the generator voltage and bus voltage
7. When you are sure there is no wiring problem, stop the generator by pressing **STOP**
8. Plug the Relay cable connector
9. Start the generator in manual mode by pressing **MAN**, then **START**
10. Press the generator breaker **0/I** button; the two generators are parallelized.

Note: If the synchronization point cannot be reached easily, refer to the chapter 0, p.42.

Check the loading ramp

⚠ WARNING
RISK OF OVERLOAD OR REVERSE kW
Check the wiring of the power lines, in particular the current transformer inputs.
Failure to follow this instruction can damage equipment

After paralleling, GENSYS starts the power management.
In any case, it matters to have power on bus bar to check the voltage measurements.
In "Display/Generator electrical meter/Global view generator", check that the consumed powers by phase are positive and balanced. Otherwise, check the wiring.
During the ramp (engine state = 4), if power is reverse, or the load remains low, increase the gain 2912 in Configuration/Control loops.

Check the load sharing

On both GENSYS units, adjust the gain 2916/2958 to have a load in proportion to the generator rating.

In event of uneven load sharing:

1. Check the wiring direction of the current transformers and the power measurements. The power by phase must be balanced and positive.
2. Check the speed control is correctly configured and performs the same action on all speed governors.
3. Check that all engines are stable. If one or more engines oscillate in frequency (even slightly), this oscillation affects the load sharing.

Note: To improve the function, refer to the chapter 4.4.1, p.45.

If the load sharing is steady, but one generator always takes more load than another, adjust the off-load speeds (engine started, no paralleling) on the ESG.

6 HUMAN-MACHINE INTERFACE

GENSYS offers several interfaces for setup and monitoring:

- the built-in LCD screen
- CRE Config software application interface
- a PC web browser
- mobile phones (monitoring) in conjunction with BSD.

On these interfaces, the pages are organized similarly.

The CRE Config software is outlined in a specific manual; specific pages are described further. The splash page text is customized in CRE Config/System/Display properties.

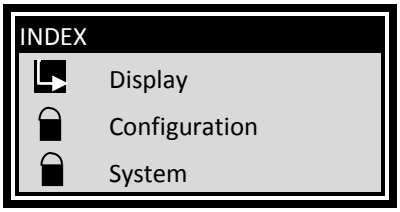
6.1 SECURITY AND OPERATIONS THROUGH THE FRONT PANEL

6.1.1 Security level and password

GENSYS features password-protected access levels to define which menu and items can be accessed:

Level	Default password	Authorization	Accessible pages and items
0	No password. Press **ENTER**	By default, this level is not password protected, but you can implement one	DISPLAY menu pages only
1	**1** (digit "ONE")	User level, settings and commissioning	All three menus
2	1234	Used to change advanced settings	All items (CRE Config only);

The password can be changed in CRE Config/System.



To access the Display menu, press **ENTER**.
To access the Configuration and System menus, the padlock must be released:

1. Press ⮟ to select Configuration
2. Press **ENTER** to switch to password input mode (as for other settings); the first character is represented by a black rectangle
3. Scroll the character set by pressing ⮝ till you get the desired first character and press **ENTER** to validate it
4. Shift to the next character pressing ⮞; select the value pressing ⮝ and press **ENTER** to validate it (* substitutes for each character entered)
5. Repeat for other characters
6. To validate the password, press **ENTER**
7. To log out, wait for the time TM password set in the System menu (default value: 5 min); then the home shows and configuration is subjected to the input of a password.

6.1.2 HMI status

To inhibit some keys or buttons, go to CRE Config/System/Button inhibition.
This can also be done through 16-bit word:

Setting	Label	Description
E3557	Button inhibit	Each bit inhibit one button/key when set to 1

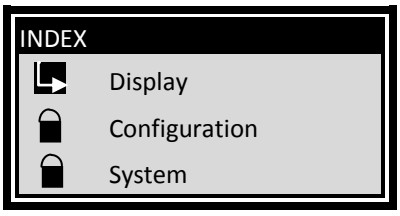
Bits numbers:

Key/Button	Inhib. bit	Key/Button	Inhib. bit	Key/Button	Inhib. bit	Key/Button	Inhib. bit
⮝	5	⮟	3	⮜	4	⮞	2
SHIFT	1	**ESC**	7	**ENTER**	6		
AUTO	15	MAN	13	TEST	14		
START	12	STOP	11	O I	10		8

For an on-demand inhibition of MAN button, refer to *3.1.3, p. 26*.

6.1.3 Navigation in LCD

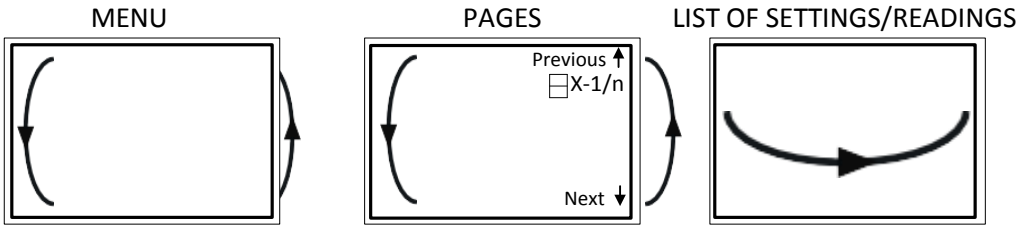
Press **ESC ENTER** and type in the level 1 password as described above to access the top level menu:



A black pointer spots the currently selected item/setting; a white one features other items/settings.
Three main menus are available on the LCD screen and the web client monitor:

- **Display** gives information on generator & busbar, & displays real-time information & status
- **Configuration** is used to hone the settings done in CRE Config/Configuration
- **System** is used to change on the fly the settings done in CRE Config/System (Date/Hour, Screen features, ...)

To cycle through the menus and menu items, press ⮟ or ⮝.
To cycle through the pages of lists of settings/readings, press ⮞ or ⮜:



6.1.4 Edition

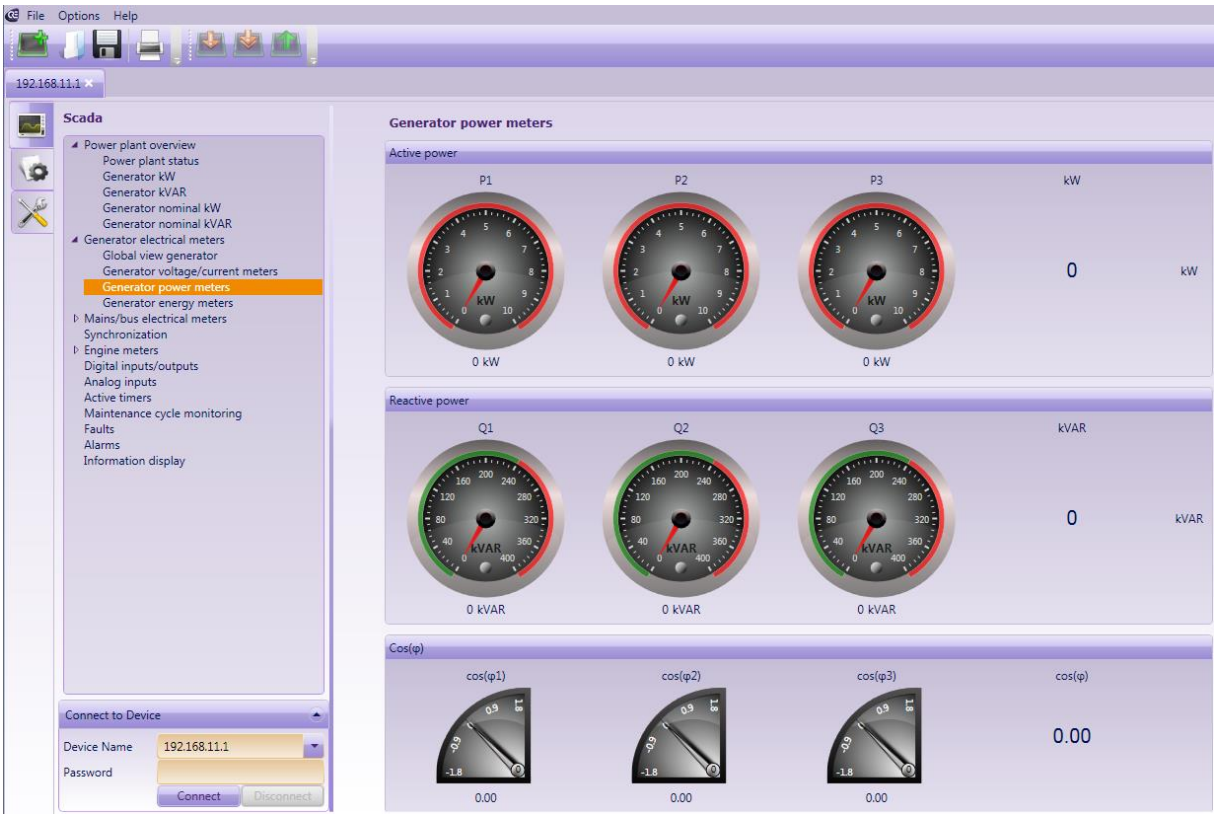
To change a setting:

1. Navigate to the setting
2. Press **ENTER** to switch to Edition mode; the current value blinks
3. Press ⮟ or ⮝ to get the new value
4. Press **ENTER** to validate the new value, **ESC** to reject it. GENSYS returns to Navigation mode.

It is also possible via the bus Modbus TCP. Refer to the chapter *7.1, p.89*.

6.2 SUPERVISION

If you keep the PC connected, you can monitor the generator from CRE Config/Scada through GENSYS.



An alarm/faults handler is built-in.

Note: In the handler, the buttons are greyed out until the PC is connected to GENSYS.

6.3 WEB SERVER

The GENSYS web server provides a very easy and efficient way of:

- loading/downloading configuration file.
- Downloading alarm/fault/log events
- Update firmware
- Visualize alarm/fault

To do so:

1. Connect GENSYS to your PC using an Ethernet direct cable
2. Start a Web browser such as Firefox or Internet Explorer
3. Type in the IP address (factory setting: http://192.168.11.1), or GENSYS hostname
4. When the GENSYS password page appears, enter your password

In the browser, the only soft key is ESC, used to return to the parent menu.

6.4 DISPLAY MENU

The **LCD** menu gives access to the following information (the letters are the ones that sneak in the LCD):

A. Power plant
B. Generator electrical meter
C. Bus electrical meter
D. Synchronization
E. Engine meters
F. Inputs/outputs state
G. Maintenance
H. About (only level 0)

A Power plant

A carousel cycles through power plant loads (shared by up to 32 different GENSYS units):

Power plant status		Generator status
GE 01 … 16	kW	Percent of nominal active power and value supplied by each generator
GE 17 … 32	kW	
GE 01 … 16	kVAR	Percent of nominal reactive power and value supplied by each generator
GE 17 … 32	kVAR	

B Generator electrical meter

These pages display in real time all generator electrical measurements in true RMS.

B- 1 Global view

- Phase-to-neutral voltage of phase 1
- Phase-to-phase voltage of phase pair 3-1
- Current of phase 1
- Total power: kW, kVAR, cosϕ

B- 2 Frequency (Hz)

B- 3 Phase to neutral (V)

- V1, V2, V3

B- 4 Phase to phase (U)

- U31, U23, U12

B- 5 Current (A)

- I1, I2, I3

B- 6 Active power (kW)

- P1, P2, P3

B- 7 Reactive power (kVAR)

- Q1, Q2, Q3

B- 8 Total power (kW and kVAR)

B- 9 Power factor

- ϕ1, ϕ2, ϕ3 I stands for Inductive, C for Capacitive (signed as per IEC convention)

B- 10 Total power factor

B- 11 Energy meters

- kWh and kVARh

Notes: The frequency is available if the phase-to-neutral voltage exceeds 15VAC. These pages fit the preset voltage system (see further).

C Bus

These pages display in real time all bus electrical measurements.

C- 1 Global view

- Phase-to-neutral voltage of phase 1
- Phase-to-phase voltage of phase pair 3-1

C- 2 Frequency

C- 3 Phase to neutral (V)

- V1, V2, V3

C- 4 Phase to phase (U)

- U31, U23, U12

Note: These pages fit the voltage system selected (see further)

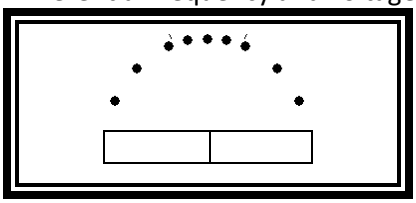
C- 5 Total power (kW & kVAR)

- Measure by CAN bus

D Synchronization

This page displays:

- Synchroscope (phase difference)
- Differential frequency and voltage (bar graphs)



E Engine meters

E- 1

- Oil pressure
- Water temperature
- Engine speed (RPM)
- Battery voltage

Note: This screen is the screen saver during start

E- 2

- Running hours
- Total count of starts

Note: Oil pressure, water temperature & engine speed can be measured by an analog input/pickup/J1939

If the unit is connected by J1939 to the engine, some extra pages are available to display the measurement received from the engine. (Refer to the chapter *7.3, p.94*.)

F Inputs/outputs state

F- 1 Digital inputs 1-5

The name of each input is displayed with its status: active =full dot, inactive = hollow dot.

1 (Raw) is the status of the physical input, 2 (Processed) is the status after conditioning (delay, …).

F- 2 Digital inputs 6-9

Idem.

F- 3 Digital outputs

The name of each output is displayed with its state: active =full dot, inactive = hollow dot.

F- 4 Relay outputs

This menu shows the state of the two relay outputs (Generator breaker).

The name of each output is displayed with its state: active =full dot, inactive = hollow dot.

F- 5 Analog inputs 1-3

The name of each input is displayed with its

- Value if really analog
- Status if digital: active =full dot, inactive = hollow dot.

G Maintenance

This page shows the countdown of running hours/days since the latest reset (if activated). The starting values are set in the Configuration menu or in the software application CRE Config/Configuration. (Refer to the chapter *3.6, p.39*.)

H About

These pages show only if you have entered as observer (no password). Otherwise, find it in “System/About“.

1. S/N: serial number, Type (A56Z0), Version, Boot version
2. Host name, IP, NM (network mask), GW (gateway). Refer to the chapter *2.1, p.17.*

CRE Config/Scada gives access to readings in addition to the preceding ones.

CLOCKS

Reading	Label	Description	Timeout
4450	Loss of speed sensor	Time since the speed sensor signal is not available	2203
4453	Prelubrication bef crank	Pre-lubrication time before cranking	3455
4455	Preglow	Preheating time before cranking	3456
4457	Crank	Time since crank relay is energized	3457
4458	Rest crank betw. 2 attempts	Time between cranking attempts	4459
4464	Warm up	Time generator is waiting to warm up before taking the load	3467
4465	Speed & voltage stabilization	Time generator is waiting to let engine speed & volt stabilize before taking the load (not applicable to static paralleling)	3469
4466	Voltage stabilization	Voltage stabilization counter for static paralleling	
4467	Cool down	Time generator is waiting without load before stopping engine	3470
4468	Rest after engine stop	Time the engine has been waiting since being put at rest	3472
4469	Fail to stop engine	Time of the current stop sequence	
4476	Fail to start engine	Time GENSYS waits a response from an external auto start module since the start request	3469

J1939 VALUES, ETC

6.5 CONFIGURATION MENU

To access this menu, a password is required; the **LCD** menu gives access to the following information:

A. Power plant
B. Generator
C. Bus
D. Engine
E. Protections
F. Timers (Timeouts and delays)
G. Synchronization
H. kW/kVAR control loops
I. Modification by variable n°

The letters are the ones that sneak in the LCD; the settings with a purple left border are for CRE Config only. A full index indicates the current selection.

A Power plant

Setting	Label	Value	Description
2001	Number of module	1 … 32	Number given to this particular GENSYS on the CAN bus
2000	Total count of modules	1 … 32	Total count of GENSYS units installed on the CAN bus
2050	Paralleling mode (1)	No [0]	Standard synchronization: carried out by adjusting engine speed and generator voltage
		Yes [1]	Breakers are closed before engine start and generator excitation
2002	Deadbus management	No [0]	An external logic controls dead bus management
		Yes [1]	Dead bus management via inter GENSYS digital CAN bus
2003	Voltage schema	Monophase [0] Biphase 180° [1] Triphase 120° [2]	Voltage system selection

(1) Select the menu item Options/Advanced

B Generator

B- 1 Generator

Setting	Label	Description
2105	Nominal kW	Generator nominal active power
2107	Nominal kVAR	Generator nominal reactive power
2102	Nominal voltage	Generator nominal voltage
2106	Nominal kW 2	Second nominal power of the generator, activated with logical input
2108	Nominal kVAR 2	Second nominal reactive power of the generator, activated with logical input

B- 2 Generator

Setting	Label	Description
2100	PT ratio	Ratio of the voltage transformers (Ex: 20 kV to 100 V: type in 200). Default value: 1
2101	CT ratio	Ratio of the current transformers (Ex: 100A to 5A: type in 20). Maximum ratio is 3250 (for e.g. 3250:1 or 16250:5). Default value: 100

WARNING
RISK OF BREAKER STATE MODIFICATION
Do not switch from one mode to another when the plant is in use.
Failure to follow this instruction can damage equipment

B- 3 Generator

AVR CONTROL

Setting	Label	Description
2251	AVR amplitude	AVR trip. Refer chapter *5.3, p.62*
2252	AVR offset	Middle output voltage to AVR
2255	PF nom	Power factor set point
2851	kW low lim	Threshold where GENSYS opens the generator breaker after an unload ramp. Enter a value above [2412] (refer to the chapter 3.3, *p.34*)
2109	kW nom	Generator nominal active power set point
2110	kW2 nom	Generator nominal active power alternative set point
2853	Load ramp timer	Time to ramp up from lower limit [2851] to nominal
2856	Unload ramp timer	Time to ramp down from upper power limit [2852] to lower power limit
2806	Resynchronization timer	Refer to the chapter *4.4.2*
2807	Max nb of resynch	

C Bus

Setting	Label	Comment
2150	PT ratio	Ratio of the potential transformers

D Engine

Setting	Label	Possible value	Comment
2205	ESG amplitude	0…10.0V	Refer to the chapter *5.3, p.62*
2206	ESG offset	–10.0V…+10.0V	
3452	Auto start seq	Internal start sequence [0]	GENSYS manages the start sequence
		External auto start module [1]	An external module manages the start sequence

CRANK SETTINGS

This menu does not show if an external start sequence has been selected in CRE Config/Configuration /Engine/Start settings.

Setting	Label	Description
2200	Speed measurement	If Magnetic, Count of teeth on flywheel is required (default value = 2) If Alternator, Pole pair number is required (default value = 2)
3461	Starts attempts	Count of start attempts (Default value = 3)
3100	J1939	If installed on engine, select the engine manufacturer and ECU type
3459	Count starters	Starter order
3462	Crank 1 drop out	Speed (RPM) above which the engine is considered to be started for starter 1
3463	Crank 2 drop out	Speed (RPM) above which the engine is considered to be started for starter 2
3464	Crank 3 drop out	Speed (RPM) above which the engine is considered to be started for starter 3
3474	Preheat coolant temperature threshold	Refer to *3.2*
3473	Oil pressure threshold	ibidem
3475 (3)	Air conditioning thresh	ibidem
3053 (3)	Control on CAN2 fault	Effect of a CAN2 bus fault
3468	Idle speed	The engine speeds up from crank disconnect value to idle speed; then the

Setting	Label	Description
2207	Nom speed 1	First speed set point (default). Used for protection
2208	Nom speed 2	Second speed set point. It can be activated with digital input
2204	Speed droop	Droop of the internal speed controller. Refer to the chapter *4.4.2*

(1) Available according to Speed measurement [2200]
(2) Idle speed must be set to nominal speed 1 value [2207] if the internal speed controller is not used
(3) Select the menu item Options/Advanced

If an ECU has been selected, set the protections according to the information received by J1939:

Setting	Label	Description
3104	Control on high speed	Protection associated to a high speed
3105	Control on very high speed	Protection associated to a very high speed
3106	Control on high cool temperature	Protection associated to a high water temperature
3107	Control on very high cool temperature	Protection associated to a very high water temperature
3108	Control on low oil pressure	Protection associated to a low oil pressure
3109	Control on very low oil pre	Protection associated to a very low oil pressure
3110	Control on DM1 smoke	Protection associated to an emission-related trouble code active
3111	Control on DM1 engine protection	Most probably not electronic subsystem related. For instance, engine coolant temperature may exceed its prescribed temperature range
3112	Control on DM1 warning	Protection associated to problem where engine needs not immediate stop
3113	Control on DM1 alarm	Protection associated to a severe enough condition to trigger engine stop

E Protections

All protections (Generator and Engine/Battery) work with:

- A threshold: triggering level of protection
- A timer: time before triggering the protection
- An action to do when the fault is present

	Protection	1 (alarm)			2 (fault)		
		Threshold	Delay	Action/alarm	Threshold	Delay	Action/fault
	Over speed	2350	2351	2352	2368	2369	2370
	Under speed	2353	2354	2355	2371	2372	2373
	Min oil pressure	2362	2363	2364	2380	2381	2382
	Max water temp	2365	2366	2367	2383	2384	2385
	Min battery voltage	2356	2357	2358	2374	2375	2376
	Max battery voltage	2359	2360	2361	2377	2378	2379
	Protection	1 (alarm)			2 (fault)		
		Threshold	Delay	Action/alarm	Threshold	Delay	Action/fault
	Over frequency	2400	2401	2402	2436	2437	2438
	Under frequency	2403	2404	2405	2439	2440	2441
	Over voltage	2406	2407	2408	2442	2443	2444
	Under voltage	2409	2410	2411	2445	2446	2447
	Mini kW	2412	2413	2414	2448	2449	2450
	Maxi kW	2415(1)	2416	2417	2451	2452	2453
	Reverse kW	2418	2419	2420	2454	2455	2456
	Mini kVAR	2421	2422	2423	2457	2458	2459
	Maxi kVAR	2424	2425	2426	2460	2461	2462
	Reverse kVAR	2427	2428	2429	2463	2464	2465
	Over current	2430	2431	2432	2466	2467	2468
	Over neutral current	2433	2434	2435	2469	2470	2471
Uneven load sharing	Uneven kW	3708	3709	3710	–	–	–
	Uneven kVAR	3711	3712	3713	–	–	–

(1) Must be under the DBR (intermittent) and MCR (Max continuous rating) curves. Refer to *Appendix Standards ISO3046*.

	Protection	k	c	α	TMS	Is	Action/fault
See curves in *Appendix*	Short circuit	2472	2473	2474	2475	2476	2477
Standard inverse IEC curve c=0	Default value	0.14	0	0.02	0.01	110	–

F Timeouts and delays

A page describes the settings for the engine start sequence. Refer to chapter *3.2, p.27*.

Setting	Label	Description
3455 (2)	Prelubrication	Time to energize a prelube output for a lubrication pump before cranking
3456 (2)	Preglow	Time to energize a preglow output for preheat plugs before cranking
3457 (2)	Cranking	Maximum time for which the crank relay is energized during a start attempt
4459 (2)	Crank Rest	Time to wait between two cranking attempts
3467 (2)	Warm up	Time to wait before taking the load to allow the engine to warm up
3469	Stabilisation	Time to wait for speed and voltage to get steady
4852 (2)	Protection valid	Delay before enable protections (oil pressure, underspeed) when starting engine
2203	TM sensor lost	Time after a "sensor lost" security fault will be triggered if no signal is read from speed measurement input
3470	Cooling	Time the engine will run without load before stopping
3471 (2)	Stop engine (rest)	Delay after which the engine is considered to be not stopped
3472 (2)	Rest time after normal stop	The minimum time the engine will wait before re-starting after being put at rest
3478	Horn delay	Drop-off delay. Refer to *0, p. 35*
3453	Fail start to start	Time to wait before trigger a fail to start fault
3454 (1)	Max prelub timer	The longest acceptable delay for engine start. Refer to *3.2.4, p. 32*

(1) Available if an external start module has been selected
(2) Not available if an external start module has been selected

G Synchronization

This page allows setting the synchronization settings used to allow the synch check relay to operate.

Setting	Label	Description
2810	Voltage match	Maximum difference (in %) between generator and bus bar voltage for coupling
2811	Freq. match	Maximum frequency difference between generator and bus bar for coupling
2802	Phase match	Maximum phase angle difference between generator and bus bar for coupling
2803	Fail to synch.	Allocated time to synchronize
2809 (1)	C2S dwell time	Synchronization dwell time before authorizing to close the breaker
2804	Control on fail	Selects the action in case of synchronization fails

(1) This setting can be modified using TXT file or modification by variable number menu

Used to tune the frequency and phase synchronization PID to decrease the synchronization time. The built-in synchroscope shows and lets you monitor in real time any change made on these settings.

Setting	Label	Description
	Voltage	
2950	G	Global gain of the voltage synchro
2951	P	Proportional gain of the voltage synchro
2952	I	Integral of the voltage synchro
	Frequency	
2900	G	Global gain of the frequency synchro
2901	P	Proportional gain of the frequency synchro
2902	I	Integral of the frequency synchro
	Phase - Angle	
2904	G	Global gain of the phase synchro
2905	P	Proportional gain of the phase synchro
2906	I	Integral of the phase synchro

H Control loops

H- 1 kW control

Setting	Label	Description
2917	P	Proportional gain of active load sharing
2918	I	Integral of active load sharing

FREQUENCY CENTERING

Setting	Label	Description
2927 (2)	Hz center act	Activation of the frequency centering
2926 (1)	Hz center gain	Global gain of the frequency centering

(1) Select the menu item Options/Advanced
(2) This setting can be modified using TXT file or modification by variable number menu (1 by default)

H- 2 kVAR control

Setting	Label	Description
2959	P	Proportional gain of reactive load sharing
2960	I	Integral of reactive load sharing

H- 3 Ramp kW

Setting	Label	Description
2913	P	Proportional gain of ramp kW

H- 4 Ramp kVAR

Setting	Label	Description
2967	P	Proportional gain of ramp kVAR

I Modification by variable number

This page is very useful when you are familiar with key variable numbers, for example the ones you often modify. Simply enter the variable number, and then enter its value.

Note: You can only change settings 2xxx…3xxx and, if allowed, 4500…4649. Some are not accessible in regular menus.

CRE Config EXTRA SETTINGS

These settings can still be set changed through the LCD (screen I).

POWER MANAGEMENT SYSTEM (LOAD DEPENDENT START/STOP)

Setting	Label	Possible value	Description
2850	Load/Unl. mode	[0] Inhibited [1] GE number [2] Hours run [3] By custom	No automatic start/stop of generators according to aggregate load Generators start/stop according to the Generator number Generators start/stop according to the GENSYS running hour meter Generators start/stop according to my priority number [2863] (1 … 32)
2864	Load dep kVAR	[0] kW [1] kVAR	Kind of power used in this strategy
2854	LV Load thres	Default: 80%	Percent of load on the power plant above which another engine is requested to start and share the load
2857	LV Unload	Default: 20%	Percent of load on the power plant under which an engine is stopped. Used when E2859 = 0
2855	TM before load	Default: 10.0s	Delay with power above threshold E2854 before GENSYS requests another generator to start and share load
2858	TM before unload	Default: 10.0s	Delay before deciding to reduce the count of running generators in load/unload management

GENERATOR

Setting	Label	Description
2300	Gen brk ctrl	Generator breaker control: it can take one of the six values that follow
2304	Fail to O/C br	Timeout before breaker opening/closure failure

Value		
0	Open contact	Close pulse
1	Open contact	Close contact
2	Open MNcoil	Close pulse
3	Open MNcoil	Close contact
4	Open pulse	Close pulse
5	Open pulse	Close contact

For details, refer to the chapter *8.4, p.113*.

GENERATOR ELECTRICAL FAULT

Setting	Label	Description
2806	Re-sync delay	Delay before the GENSYS tries to re-synchronize with busbar
2807	Nb re-synch.	Maximum allowed re-synchronization launches before forced stop

DIGITAL INPUTS AND OUTPUTS, AND CANopen

Refer to the chapters *8.3, p.105* and *7.2, p.92.*

FIFO DATA LOGGER

GENSYS can save up to 2,000 pieces of data. In addition to Engine state and Power state, up to 10 readings/statuses can be selected. This includes archived alarms and faults. They are archived on change of value.

Format:

jj/mm/aa hh:mn:ss.100ms label XXXX=YYYY . XXXX = parameter number, YYYY = value.

In CRE Config/Configuration/Logger:

- Tick the box Log on/off to enable the data logger
- Enter the codes in the text area (using the spin is NOT recommended as you have to scroll a lot).

The records can be downloaded from CRE Config or the web site.

RUNNING HOURS CYCLES

This page allows you to

- set the duration of five cycles in hours and five cycles in days
- reset the cumulative duration

Refer to the chapter *Operation/Running cycles*.

Setting	Label	Description
3500	Cycle1 (h)	Duration of cycle 1 in cumulative running hours
3501	Cycle2 (h)	Duration of cycle 2 in cumulative running hours
3502	Cycle3 (h)	Duration of cycle 3 in cumulative running hours
3503	Cycle4 (h)	Duration of cycle 4 in cumulative running hours
3504	Cycle5 (h)	Duration of cycle 5 in cumulative running hours
3505	Cycle1 (d)	Duration of cycle 1 in cumulative running days
3506	Cycle2 (d)	Duration of cycle 2 in cumulative running days
3507	Cycle3 (d)	Duration of cycle 3 in cumulative running days
3508	Cycle4 (d)	Duration of cycle 4 in cumulative running days
3509	Cycle5 (d)	Duration of cycle 5 in cumulative running days

6.6 SYSTEM MENU

It gives access to the following pages where with readings, or settings to modify:

A. Date/Time
B. Screen setup
C. Ethernet
D. About (read only)

Note: In CRE Config, the buttons are greyed out until the PC is connected to GENSYS.

A Date / Time

"Date / Time" allows you to modify the date and the time:

Label	Description
Date	Year/Month/Day/Day of week
Time (hh:mm)	Time adjustment (H M)

GENERATOR METER SETTING

When GENSYS is not connected to a new generator, set in CRE Config the initial values of energies, count of starts and running hours.

B Screen setup (Display properties and password)

Setting	Label	Default	Description
3554	Contrast	50%	Adjustment of LCD contrast from 0 to 100% when electronic is compatible
3555	Backlight	100%	Adjustment of LCD backlight from 0 to 100% of the max backlight intensity
3552	Backlight saver timeout	5 min	Time (in minutes) after which the backlight turns off
3553	Password timeout	5 min	Time (in minutes) after which the display exit menus and show screen saver
3551	Screen saver timeout	5 min	Time (in minutes) after which the display backlight is switched off. The light is switched on again as soon as a key is pressed
–	Line 1 to Line 2	CRE Tech its URL	The two lines of text displayed in the Splash screen saver can be modified on the fly. Each line can include up to 21 characters in length

C Ethernet

This page displays some information on module and on Ethernet connection.

- DHCP status
- IP address
- Network Mask
- GateWay IP address
- HTTP port
- Modbus port

D About

This page displays some information on module and on Ethernet connection.

- Serial number (S/N)
- Module reference (type)
- Software version
- Boot software version
- Hostname
- IP address
- Network Mask
- GateWay IP address

CRE Config EXTRA SETTINGS

METERS

"Meters reset" allows you to reset the following meters:

- kW generator sum
- kVAR generator sum
- Running hours
- Count of starts
- Event logger

Meters preset allows you to preset the following meters:

- kW generator sum
- kVAR generator sum
- Running hours
- Running minutes
- Count of starts

SCREEN SAVER

The page displayed when the user does not interact with GENSYS (keys not used) is called "SCREEN SAVER". Information displayed on this page depends on the GENSYS status, as described in the following table. Some settings can also be used to customize this behaviour.

Screensaver	Description	Displayed in AUTO mode	Displayed in MAN mode
Synchronization column	Frequency difference (bar graph) Voltage difference (bar graph) Phase difference (column) Frequency match (OK/NOK) Voltage match (OK/NOK) Phase match (OK/NOK)	In synchronization state	When the generator is ready and the generator breaker is open
Generator overview	KW (in large font) Voltage (in large font) Running hours (in large font)	When the generator breaker is closed	When the generator breaker is closed
Engine overview	Water temperature Oil pressure Battery voltage Engine speed	In start and fault states	When you press START, or in fault state
Customized screen	2 custom lines Current date and time	In waiting state (the engine waits for a start request)	In other cases

PASSWORD

This page allows you to change passwords, from level 0 to the currently connected level. Passwords are limited to 8 characters maximum. Refer to this chapter's beginning.

LANGUAGES

Setting	Label	Possible value	Description
3556	Language	English Francais Espanol Italian	Language of the menus displayed on the PC and the LCD

Note: It is possible to add a custom language. Refer to chapter Maintenance.

COMMUNICATION PORTS CONFIG

INTER-GENSYS CAN
This isolated communication port is dedicated to inter-unit data communication using a proprietary protocol. This bus is designed for synchronization, load sharing (active and reactive), dead bus management, automatic load/unload, data broadcast, ... Action to be performed upon CAN bus fault [3052] occurrence can be set (select menu Options/Advanced).

CANopen-J1939
This bus is used for communication with CANopen remote I/O modules (Beckhoff, Wago...) or electronic engines communication (J1939).

ETHERNET
This page allows you to configure the Ethernet connection to communicate with a PC. Please contact your network administrator to configure router and module(s) according to your need.

Setting	Label	Default	Description
3012	DHCP select	1	[Enable]: DHCP protocol (dynamic IP address) enabled [Disable]: fixed IP address
3000…3003 (1)	IP Address	192.168.11.1	Fixed IP address of the unit (DHCP disabled or in fault)
3008…3011 (1)	IP GW address	0.0.0.0	Gateway IP address (DHCP disabled)
3004…3007 (1)	IP NM	255.255.255.0	Network mask (DHCP disabled)
3013	Port HTTP	80	TCP communication port
3014	Port Mod TCP	502	Modbus TCP communication port

(1) Only available if DHCP protocol is disabled.

Note: modification of port numbers is taken into account during power on sequence. Restart GENSYS.

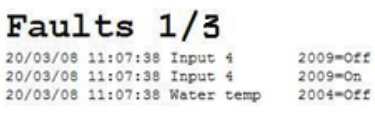
DEDICATED PAGES

The dedicated pages include:

- The faults page
- The alarms page
- The information page.

Faults and alarms

At any time and any level, click the link Faults or the link Alarms in the browser or press the key **FAULT** or **ALARM** on the front panel. To return to the previous page, click ← on the browser or press again the button. The latest 30 faults and 30 alarms show. They are time-stamped as follows:
dd/mm/yy hh:mn:ss protec. label XXXX=On (or Off). XXXX is the variable number.
With the keys, navigate between the pages of active faults/alarms: 1st … 3rd faults/alarms, 4th … 7th faults/alarms, etc



To update the page with the latest faults(s), press Refresh.
To reset the tripped protections, press Reset in the “Active faults/ Active alarms” page.

Note: Fix the condition triggering the protection before clearing the alarm; failure to do this will trigger the protection again.

To delete the Faults/Active archive, in “System/ Date-Time/Meter/Meters reset”, select Event logger.

Information

At any time and any level, you can press the  key on the front panel (in the browser, click the link **Information**). Press the key again to return to the previous page (in browser, click Back). This changes the display and show the information screen.

```
Information
Power    :   <Elapsed time> <State>
Engine   :   <Elapsed time> <State>
```

Power [4001] displays the unit current state regarding power management. It displays also a state code which is dedicated to the technical support team of your local distributor.

Engine [4000] displays the unit current state regarding the engine. It displays also a state code which is dedicated to the technical support team of your local distributor.

Custom parameters

To display any reading, enter its 5-digit code (without E). As in CRE Config/Scada, you can customize the information page with 10 readings, generally current state or deviations (refer to the chapter *5, p.59).* They show in the text file with label “Info 1.n” (n= 1…10).

7 COMMUNICATION BUSES

7.1 MODBUS TCP

7.1.1 Capabilities

The complete list of variables is in the file ***A56Z0 90030_.xls***.
Through an Ethernet communication where GENSYS acts as a Modbus TCP server, you can

- Upload many readings and GENSYS internal variables
- Download values for many GENSYS internal variables:

Level	Nature	Range	Access right by nature
0	Readings (measurements, statuses)	0000 … 1999	Read only
1	Settings	2000 … 3999	Read/Write
2	Modes, statuses, settings Readings associated with digital inputs	4000 … 9999 4500 … 4649	Read Write (subject to activation)

In addition, in order to decrease load on Ethernet, the following functions are supported:

- Reading Bit Fields, listed in a dedicated tab of the file and organized in 16-bit words
- Reading contiguous configurable data block

7.1.2 Configuration

To communicate through Modbus TCP, define the following settings:

- GENSYS IP address set in CRE Config/System/Network configuration
- Modbus TCP port [3014], generally 502, set in CRE Config/System/Network configuration
- Modbus rights: see further

GENSYS handles up to 4 Modbus TCP connections. This can be used for multiple HMIs for example.

For more details on the Ethernet configuration, see the chapter *2.1, p.17*.

7.1.3 Description

⚠ WARNING
RISK OF UNINTENDED EQUIPMENT OPERATION
Stop the engine before changing settings
Failure to follow this instruction can damage equipment

Functions

GENSYS supports the following Modbus functions:

Function	Description
01, 02	Read logical values (coil status, discrete input status)
03, 04	Read holding/input registers (16 bits)
05	Write logical value (single coil)
06	Write single register (16-bit variable)
15 (0x0F)	Write multiple logical values (multiple coils)
16 (0x10)	Write multiple registers

Data 10000…10299 can be read by block. See further.

The 32-bit variables can be written to only with function 0x10.

All GENSYS variables are 16-bit registers. Yet it might be useful to consider them as logical values (if they are only set to 0 or 1) to simplify Modbus communication with some external PLC. If function 01 or 02 is used to read an internal register that is different from 0, then returned value will be 1.

GENSYS registers start from address 0. Depending on your Modbus TCP client equipment-software, you may need to use an offset of 1 when reading/writing registers as addresses may start from address 1. In this case, request address/register number 1 to access variable 0000 inside GENSYS.
If a digital input modifies a piece of data also to be written by Modbus, the latest request takes over the other.

Access rights

The access rights depend on the parameter nature and on massive and individual permissions. To grant massive access rights, set to 1 the corresponding bits in the word 3015:

	Writing using Modbus TCP	Reading using Modbus TCP	Not used	Not used	Not used	Not used	Not used	Writing to input function registers	Writing to Engine counters	Writing to Date/Time
Bit #	9	8	7	6	5	4	3	2	1	0
Default value	1	1	0	0	0	0	0	0	0	0

In CRE Config/System/Network configuration/Modbus access rights, just tick a checkbox:

Bit #	Label	Use
0	Writing to Date/Time	Synchronization of GENSYS clock. See chapter *A, p.84*
1	Writing to Engine meters	Manual adjustment of counters (see next table). See chapter *A, p.84*
2	Writing to digital input function register	
8	Reading using Modbus TCP	Opens the possibility to grant reading individual permissions
9	Writing using Modbus TCP	Opens the possibility to grant writing individual permissions

The counters, encoded on 32 bits, include:

Counters (MSB|LSB)	Label
0080|0079	Generator kWh
0082|0081	Generator kVARh
0084|0083	Engine running hours

Bit Fields

Bit fields are meant for decreasing communication bus load. They pack up to 16 logic variables inside a single register. This way a single Modbus request can be used to read a chunk of information. Each variable contains the current value of 16 logic variables such as breaker positions, faults, alarms…

They are listed out in the Bit fields tab of the document ***A56Z0 90030_.xls.***
The bit fields 0956 … 0969 have latched values: a reset is required for them to return to 0

Custom blocks

To create your own blocks, use the variables 10000 … 10299 in CRE Config/Configuration/Modbus.

There are two ways to configure these blocks:

A. Configuration in CRE Config/Modbus: enter the codes of the variables to read; the readings on the registers 10000 … 10299 will be the pointed values

B. Configuration by an external device; this device must request the following:
   1. Write 1 to 3016 to enter into the configuration mode

2. Write the codes to the desired registers (10000 … 10299)
3. Write 0 to 3016 to enter into the read mode
4. Read the register (10000 … 10299)

Then to read your own block, you just need to read by Modbus the register 10000 to 10299.
Time stamping is done by the master.
Example:
If the configuration is as follows E10000 = 14; E1001=15; E10002=16, the reading by Modbus of the 3 registers will give to you the hours/minutes/seconds of the GENSYS.

Later, CRE Config can upload the new configuration if needed.

Modbus communication example

The table below exemplifies a Modbus TCP client sending a reading request (function 04) of 6 registers starting from variable 0079.

Client request		**GENSYS server response**	
Field	Value	Field	Value
MBAP header		MBAP header	
Function code	04	Function code	04
Starting register (MSB)	00	Data bytes (=2 x count of requested registers)	12
Starting register (LSB)	79	Value of register 0079 (MSB)	*D0*
Count of registers (MSB)	00	Value of register 0079 (LSB)	*D1*
Count of registers (LSB)	06	Value of register 0080 (MSB)	*D2*
CRC32	*XX*	Value of register 0080 (LSB)	*D3*
		Value of register 0081 (MSB)	*D4*
		Value of register 0081 (LSB)	*D5*
		CRC16 (MSB)	*YY*

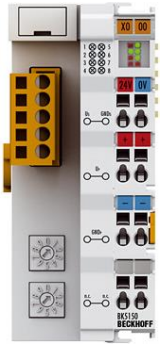
Note: Available data are related only to faults that occurred after the latest power up sequence. Events that occurred before GENSYS has been power cycled are listed in the FAULT pages but NOT among the variables.

7.2 CANOPEN EXTENSION MODULES

CANopen extension modules can be used to increase the number of digital inputs and outputs of GENSYS. Overall max. count of added inputs: 32 I and 32 O. They are read/written to every 100ms.

7.2.1 Hardware

Each bus coupler is a slave node that supports up to 64 I/O modules that offer different kinds of I/O. Outputs can be by transistors or relays. I/Os can be distributed across up to 4 daisy-chained couplers.

Manufacturer	WAGO	BECKHOFF		VIPA
Bus coupler	 750-3xx	 BK5150	 LC5100 (low cost, no isolation)	 VIPA053-1CA00
	ID by DIP switch	ID by rotary switch	ID by DIP switch	ID by DIP switch
I/O modules	75x-4xx (inputs) 75x-5xx (outputs)	KLxxxx	All the digital I/O terminals are supported except the KL15xx, KL25x2, KL2692 and KL27x1 terminals	VIPA 021-1BF50 (inputs) VIPA022-1BF00 (outputs)

The modules are stackable and mounted on a DIN-rail. Refer to the extension module's user manual for correct wiring on the CANopen module side. Check whether the inputs/outputs are protected against short-circuits. If needed, connect the drain to the DIN rail.
Make sure there is a resistor of 120Ω between CAN H and CAN L on both ends of the cable. For details, refer to the *Appendix CAN bus good practices*. Available bit-rates: 125/250/500 kbps, 1 Mbps.

Note : CANopen can be used in parallel with J1939 at 250 kbit/s.

7.2.2 Configuration

Setting	Label	Value	Description
3151	CANopen config	1	8 inputs + 8 outputs of coupler ID# 1 whose default ID is 0
		2	16 inputs + 16 outputs of coupler ID# 1
		3	32 inputs + 32 outputs of coupler ID# 1
		4	Custom configuration, defined by more settings
3153	CANopen ID# 1	0 … 255	Identifier of the first coupler
3154	CANopen IN 1	0 … 32	Count of inputs on the first coupler
3155	CANopen OUT 1	0 … 32	Count of outputs on the first coupler
3156	CANopen ID# 2	0 … 255	Identifier of the second coupler
3157	CANopen IN 2	0 … 32	Count of inputs on the second coupler
3158	CANopen OUT 2	0 … 32	Count of outputs on the second coupler
3159	CANopen ID# 3	0 … 255	Identifier of the third coupler
3160	CANopen IN 3	0 … 32	Count of inputs on the third coupler
3161	CANopen OUT 3	0 … 32	Count of outputs on the third coupler
3162	CANopen ID# 4	0 … 255	Identifier of the fourth coupler
3163	CANopen IN 4	0 … 32	Count of inputs on the fourth coupler
3164	CANopen OUT 4	0 … 32	Count of outputs on the fourth coupler

The assignment of I/Os is done in the order of couplers and the lower variable number is associated to the lower message number configured.
The CANopen inputs and outputs have the same attributes as regular inputs and outputs except the Delay on drop-off of inputs (refer to the chapter *8.3*):

Setting	Attribute
Digital inputs 1 … 32	
3200 … 3231	Function
3232 … 3263	Delay on pick-up
3264 … 3295	Validity
3296 … 3327	Direction
Digital outputs 1 … 32	
3350 … 3381	Function
3382 … 3413	Mode (direction): 0: normally de-energized 1: normally energized

On power-up, the configuration is automatically launched. The status 3150 turns to 1.
The error time-out (3152) is 10.0s by default.

7.2.3 Mapping

CANopen inputs and outputs are accessed by their code:

- Inputs: 0800 … 0831
- Outputs: 4751 … 4782

7.3 J1939 COMMUNICATION

7.3.1 Overview

J1939 is a CAN protocol used by “electronic” motors, which include an ECU (or ECM, EMS). It allows you to read engine and alternator data (measurements, positions, binary values), and send commands (start, stop, speed control…). Bit rate: 250kbit/s.
By default, the external sensors are the sources; to replace them by J1939, assign the corresponding values as per the schematics in the chapters *1.1, p.12* and *3.2, p.27.*

The ECU can detect faults and send them to GENSYS. Protections can be assigned to these faults (see further).

To use the J1939 communication:

1. Enter the “Configuration/Engine/J1939“ page
2. In the list, select the manufacturer [3100]
3. Select the ECU type [3101]
4. Assign the Alarm/fault to a protection (see below)
5. Connect the engine ECU and the GENSYS J1939 port

The pair manufacturer-ECU determines the following settings:

- GENSYS address on the CAN bus
- ECU address on the CAN bus
- Speed control: through J1939 or by analog output/pulses
- Start-stop control: through J1939 or by crank and fuel digital outputs

GENSYS can communicate with a large number of J1939 engines. As the engine list accrues, please contact CRE Technology or your local distributor if your engine is not mentioned in this document.
In any case, if your ECU does not belong to the following list, try:

1. To select the generic ECU from your manufacturer
2. To select the GENERIC manufacturer, then modify the GENSYS and ECU address according to the ECU documentation

7.3.2 Measuring points and positions

The next table lists out the measuring points whose values are conveyed over the CAN bus and taken into account by GENSYS. The J1939 standard assigns each of them an SPN (Suspect Parameter Number, as it will be used to label the alarms). Refer further to the three schematics & tables for description and location.
Legend:

P	Δp	T	L	FR	Q	Tq	V	W
Pressure	Diff. pressure	Temperature	Level	Flow-Rate	Consumption	Torque	Voltage	Power

To be conveyed, they are grouped in frames; each frame is identified by a PGN (Parameter Group Number).

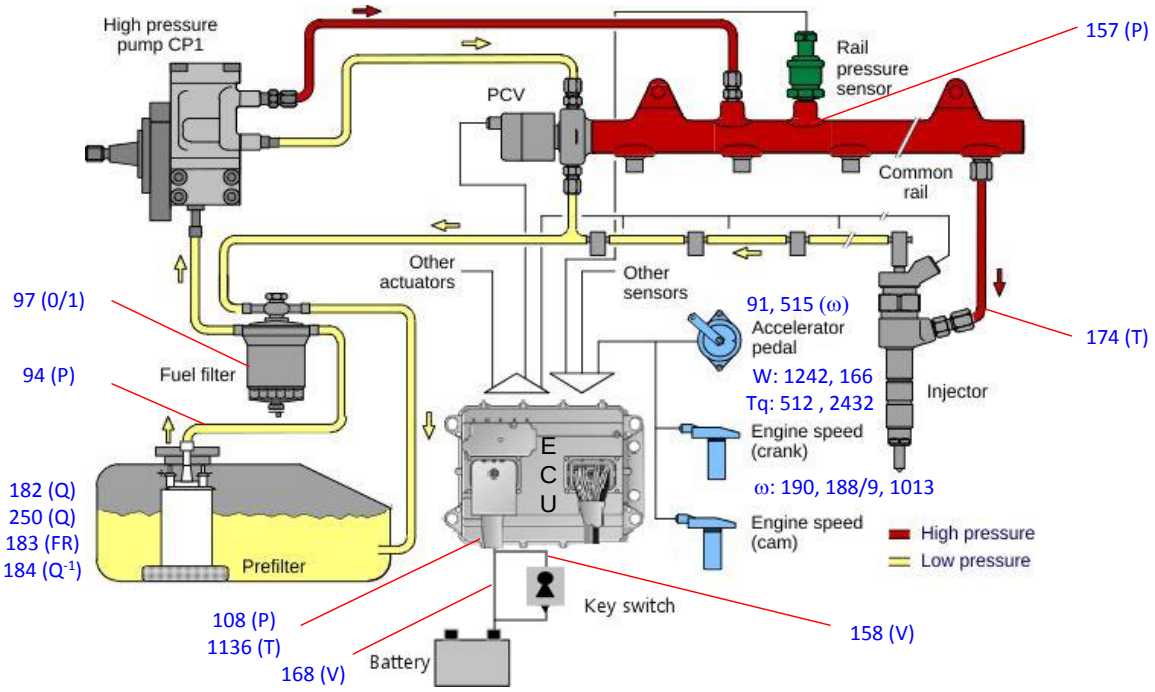
Manufacturer[3100]	ECU [3101]	Fuel & ECU (190 +	Air & Exhaust gas +Altern	Oil & Coolant
SCANIA (1) [1]	GENERIC [0]			
	S6 (DC16-45A) [1]	91 512 188 183 184 247	102 105 92 513 514	100 110 111
VOLVO PENTA [2]	GENERIC [0]			
	EMS2 [1]	94 182 250 247	102 172	100 175 110
	EDC4 [2]	Idem Deutz EMR2	Idem Deutz EMR2	Idem Deutz EMR2
	94xGE [3] 124xGE [4]	91 512 188 1013 182 94 250 183 97 158 247	102 105 92 513	100 175 110 111
	1640-2GE [5]	91 512 188 1013 182 94 250 183 158 247	102 105 92 513	100 175 110 111
	1643GE [6]	91 512 188 1013 182 94 250 183 158 247	102 106 107 173 92 513 514	100 175 110 111
	D6 [7] D7 [8]	91 512 188 1013 182 94 250 183 97 158 247	102 105 92 513	100 110 111
	D13GE-Tier3 [9]	91 512 188 1013 182 94 250 183 97 158 247	102 105 92 513	100 175 110 111
Perkins Marine Power [3]	GENERIC [0]			
	1100 A4E	91 515 188 174 250 183 247	102 105 92 513	100 110
IVECO (2) [4]	GENERIC [0]			
	NEF (EDC) [1] CURSOR [2] CURSOR9 (EDC) [3] CURSOR11 [4]	91 512-5 2432 183-4 250 97 174 158 108 247	102 105 173 81 92 513 514	100 175 110 100 110
GENERIC [5]	NA			
Cummins (3) [6]	GENERIC [0]			
	QSX15G8(CM570)[1	157 175 183 168 108	102 105 513	
	CM850 [2]			
	QSB5 (PGI 1.1) [3] QSB7 (PGI 1.1) [4]	91[a] 1242[b] 512[a] 515[a] 2432[b] 157[b] 174[a] 182-3-4[a] 247-50 168 108 97	102 105 92[a] 513 514[a]	100 1208[b] 110 111b
	QSL9 (PGI 1.1) [5]	Id+ 512[b]515[b] 184[b]94[b] 174[b]1136[b]	Id. + 92[b] 101[b] 173[b] 514[b]	Idem + 175[b] 109[b]
	QSM11 (PGI 1.1) [6]	91[a] 1242[b] 512[a] 515[a] 2432[b] 175 182 250 183 168 108 97[b] 247	102 105 92[a] 513 514[a]	100 1208[b] 110 111b
	QSX15 [7]	91[a] 512[a] 515[a] 175 182[a] 250[a] 183 168 108 247[a]	102 105 92[a] 513[a] 514[a]	100 110
	QSK19 (PGI 1.1) [8]	91[a] 1242[b] 512[a] 515[a] 2432[b] 94 97[b] 157[b]174[b]182[b]-3-4[a]247-50[b]168 108	102 105 101 92[a] 513 514[a] 22[a]	100 1208[b] 110 111b 109
	QSK38 (PGI 1.1) [9] QSK50 (PGI 1.1) [10] QSK60 (PGI 1.1) [11]	91[a] 1242[b] 512[a] 515[a] 2432[b] 157[b] 174 175[b] 94 182[b] 250[b] 183 184[a] 168 108 97[b]	102 105 101 513 514[a] 22[a] 92[a]	100 1208[b] 110 111b 109
[7] JOHN DEERE	GENERIC [0]			
	JDEC [1]	91 512 515 2432 182 250 183 184 94 157 174 158 247	107 52 106 102 105 101 173 176 81 92 513 514	98 100 175 109 110 111 112
[8] CATERPILLAR	GENERIC [0]			
	A4E2 (C4.4 C6.6)[1]	91 515 250 157 183 168 158 247	102 105 106 172 92 513	
[9] DEUTZ FAHR	GENERIC [0]			
	EMR [1]	91 512 188 183 247	102 92 513	100 110
	EMR2 [2]	91 512 183-4-8 174 158 108 247	102 105 92 513	98 100 110 111
	EMR3 [3]	91 512 2432 183 174 94 111 158 108 247	107 102 105 92 513 514	100 110 111
mtu [10] see Appendix MTU	GENERIC [0]			
	ADEC-2000 [1]	94 158 247 171 174 188 189 166 1136 1387 1388 247	52 102 2433 2434 1124-5-6	100 110 175
	ADEC-4000 [2]			
	ECU8Smart conn[3]	515 94 158-66 182-3-8-9 247-50 1136	105 3563	100 109 110
	ECU8 + SAM [4]			
[11] DETROIT DIESEL	GENERIC [0]			
	DDEC III [1]			
	DDEC IV [2]	91 512-5 188-9 174 94 157 171 182 247-50 183-4 166-8 108 158	52 102 22 101 105 106 172 107 173 176 92 513 514	98 99 100 175 109 110 111 112
	DDEC X [3]	91 512 2432 188 189 166 174 94 97 157 171 182 250 183 18 168 1136 108 158 247		

(1) By default, the Fuel output is inverted for the SCANIA engines

(2) On IVECO engine, the ECU is powered by the GENSYS Fuel output. The Crank output is activated with settable delay (2s by default)
(3) Cummins ECU can contain different firmware depending on their provenance.

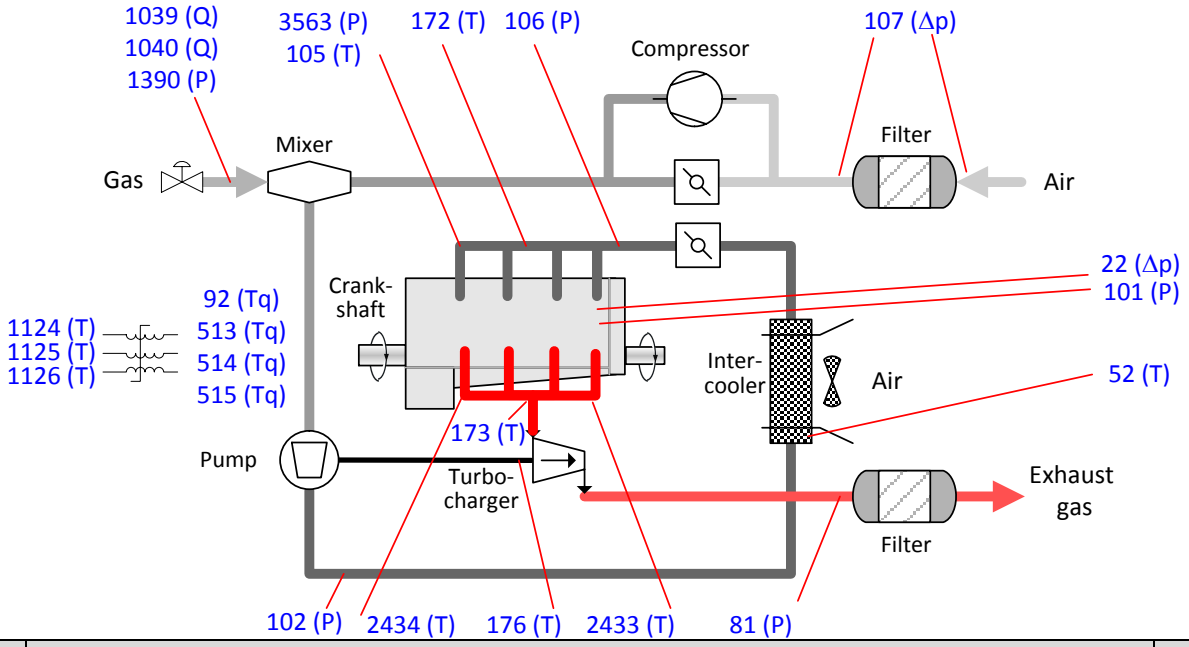
[a] Industrial models only [b] G Drive only

Fuel circuit and ECU:



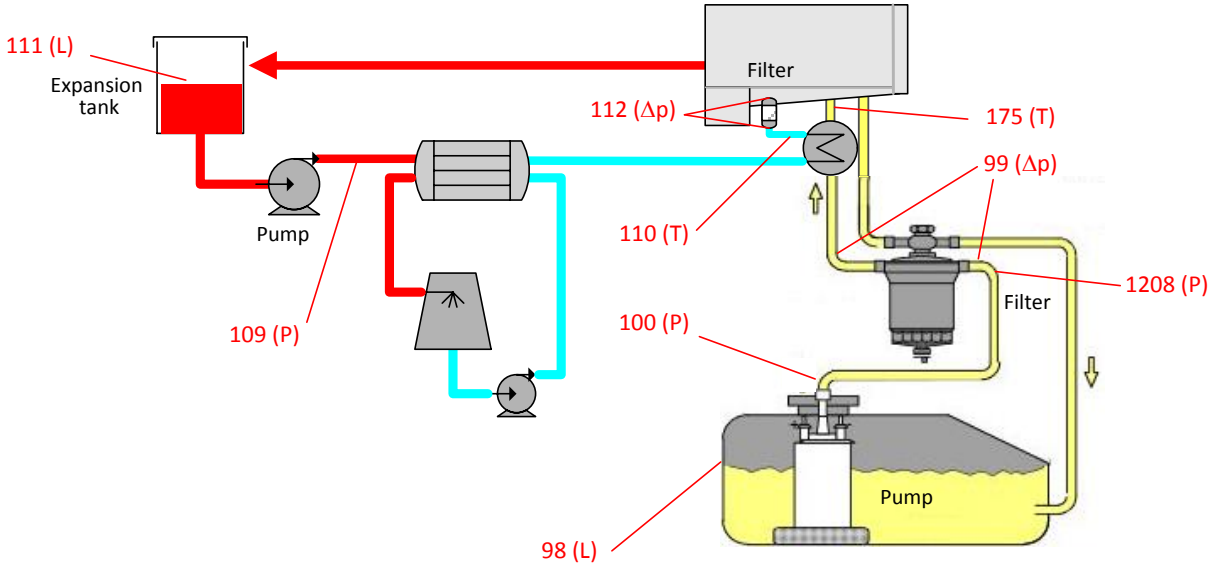
SPN	Description	PGN
91	Accelerator pedal position 1 (run in %)	F003
1242	Instantaneous estimated brake power	FE92
512	Driver's demand engine - Percent torque related to maximum engine torque	F004
515	Engine's desired operating speed. Indication of optimal speed for the current conditions. May include the torque generated to accommodate power demands & exclude dynamic commands from smoke/shift	FEDF
2432	Engine demand - percent torque	F004
190	Engine speed	F004
188	Engine idle speed	FEE3
189	Engine rated speed (max. rotational velocity of engine crankshaft under full load conditions)	FEBE
166	Engine rated power (net brake power at rated speed)	FEBE
1013	Trip maximum engine speed since latest trip reset	FEB7
171	Ambient air temperature	FEF5
182	Engine trip fuel (fuel consumed during all or part of a run)	FEE9
250	Engine total fuel used	FEE9
183	Engine fuel rate	FEF2
184	Engine instantaneous fuel economy (covered distance/fuel consumption)	FEF2
94	Engine fuel delivery pressure (as delivered by supply pump to high pressure pump)	FEEF
97	Water in fuel indicator (binary signal)	FEFF
157	Engine injector metering rail 1 pressure	FEDB
174	Engine fuel temperature 1 (at injector inlet)	FEEE
168	Battery potential /Power input1	FEF7
158	Key switch supply potential (alternative to 168)	FEF7
1136	ECU temperature	FEA4
108	Barometric pressure	FEF5
1387	Pressure auxiliary sensor #1	FE8C
1388	Pressure auxiliary sensor #2	FE8C
247	Engine total hours of operation	FEE5

Air and Exhaust gas circuits (Gas is optional) + Alternator



SPN	Description	PGN
107	Air inlet filter #1 differential pressure (first or sole filter)	FEF6
52	Intercooler temperature	FEEE
106	Air inlet pressure (at inlet to intake manifold or air box)	FEF6
102	Intake manifold #1 pressure (boost pressure measured downstream of turbo compressor)	FEF6
3563	Intake manifold #1 absolute pressure	FDD0
105	Intake manifold #1 temperature	FEF6
172	Air inlet temperature	FEF5
22	Extended crankcase blow-by pressure (differential pressure across a venturi)	FEEF
101	Crankcase pressure	FEEF
1039	Trip Fuel (gaseous) (fuel consumed during all or part of a run)	FEAF
1040	Total Fuel used (gaseous) over the engine life	FEAF
1390	Fuel valve 1 inlet absolute pressure	FE8B
2433	Exhaust gas temperature - Right manifold	FE07
2434	Exhaust gas temperature - Left manifold	FE07
173	Exhaust gas temperature (alternative to 2433 + 2434)	FEF6
176	Turbocharger oil temperature	FEEE
81	Diesel particulate filter (trap) inlet pressure	FEF6
92	Engine percent load at current speed The ratio of actual engine percent torque (indicated) to maximum indicated torque available at the current engine speed, clipped to zero torque during engine braking	F004
513	Actual percent torque The calculated output torque of the engine. The data is transmitted in indicated torque as a percent of reference engine torque. The engine percent torque value is not negative and includes the torque developed in the cylinders required to overcome friction.	F004
514	Nominal friction (percent of reference torque). Torque that compensates the engine & pumps losses	FEDF
1124	Alternator winding 1 temperature	FEA7
1125	Alternator winding 2 temperature	FEA7
1126	Alternator winding 3 temperature	FEA7

Oil and Coolant circuits:



SPN	Description	PGN
98	Oil level (ratio of sump current volume to required volume)	FEEF
99	Oil filter differential pressure	FEFC
100	Oil pressure	FEEF
175	Oil temperature 1	FEEE
1208	Oil pressure (upstream the pre-filter)	FE92
109	Coolant pressure	FEEF
110	Coolant temperature	FEEE
111	Coolant level (ratio of current volume to total volume)	FEEF
112	Coolant filter differential pressure	FEF6

These measurements show in “Display/Engine meters”. A measurement not sent by the ECU shows as “…”:

Notes: To get the measurements through the Modbus TCP port, refer to the related section.

7.3.3 Faults

GENSYS can monitor diagnostic messages (DM1) from the ECU. Only relevant diagnostic messages are taken into account and used in the GENSYS fault/alarm system. GENSYS can understand and interpret messages for display, process, and protection.

When you activate the internal GENSYS RESET (**[RESET]** button or remote reset), GENSYS sends a reset message (DM3) to the ECU. If the diagnostic message is not sent by the ECU for more than 3s, the corresponding fault/alarm is automatically reset to OFF.

Each of the following J1939 messages/alarms can be configured to trigger one of GENSYS protections.

J1939 alarm/message0/1	Fault control in CRE Config		Alarm/Message description (thresholds as set in ECU)
High speed	3104	CT speed +	Engine speed above the **least** severe high threshold
Very high speed	3105	CT speed ++	Engine speed above the **most** severe high threshold
High water temper.	3106	CT Cool Temp +	Coolant temp. above the **least** severe high threshold
Very high water temp.	3107	CT Cool Temp++	Coolant temp. above the **most** severe high threshold
Low oil pressure	3108	CT Oil Press -	Oil pressure below the **least** severe low threshold
Very low oil pressure	3109	CT Oil Press --	Oil pressure below the **most** severe low threshold
Malfunction “lamp” *	3110	CT Malfunction	Message in presence of an emission-related trouble
Protection “lamp” *	3111	CT Protection	Trouble is most probably not electronic subsystem related. E.g., coolant temp. may exceed temp. range
Amber “lamp”	3112	CT Amber	Trouble where the engine need not immediate stop
Red “lamp”	3113	CT Red	Severe enough trouble for the engine to stop

To the best of our knowledge, the lamp alarms are fully supported by previously mentioned engines/ECU of Caterpillar, Deutz, Perkins, Volvo 124xGE (broadcast) and most Cummins engines, and partially by MTU and Scania engines (*: not supported)

All thresholds are those set in the ECU. In addition of these known diagnostic messages, GENSYS shows the latest five unmanaged SPN (what is wrong)/FMI (Failure Mode Identifier, i.e. error type) combinations it has received with the diagnostic message (DM1). These SPN/FMIs are backed up in registers:

Register		Description
0664 0665 0666	J1939 SPN LO 1 J1939 SPN HI 1 J1939 FMI 1	Latest SPN/FMI received by GENSYS
0667 0668 0669	J1939 SPN LO 2 J1939 SPN HI 2 J1939 FMI 2	Second latest SPN/FMI received by GENSYS
0670 0671 0672	J1939 SPN LO 3 J1939 SPN HI 3 J1939 FMI 3	Third latest SPN/FMI received by GENSYS
0673 0674 0675	J1939 SPN LO 4 J1939 SPN HI 4 J1939 FMI 4	Fourth latest SPN/FMI received by GENSYS
0676 0677 0678	J1939 SPN LO 5 J1939 SPN HI 5 J1939 FMI 5	Fifth latest SPN/FMI received by GENSYS

SPN LO corresponds to LSB, SPN HI to MSB

Note: In any case, a fault/alarm is activated on reception of an unknown SPN/FMI if the Red [3113]/ Amber [3112] control has been set. It is deactivated by Reset.

7.3.4 Controls

SPN	Description	Details	PGN
898	Requested speed	Engine speed which the engine is expected to operate at if the speed control mode is active OR which the engine is not expected to exceed if the speed limit mode is active	0
970	Start-Stop	Engine shutdown switch	F001
2881	Frequency selection	Ability to switch the rated speed. Switched on a state transition while engine speed is 0. 50/60Hz (CM570 & PGI) or sources given through a nibble (e.g. see *Appendix/MTU/ECU8*)	FDCB

Manufacturer [3100]	ECU [3101]	Requested speed	Start-Stop	Freq. selection
SCANIA (1) [1]	GENERIC [0]	x	x	-
	S6 (DC16-45A) [1]	x	x	-
VOLVO PENTA [2]	GENERIC [0]	x	-	-
	EMS2 [1]	x	x	x (multispeed motors)
	EDC4 [2]	x	-	-
	94xGE [3]	x	x	x
	124xGE [4]	x	x	-
	1640-2GE [5]	x	x	x
	1643GE [6]	x	x	x
	D6 [7]	x	x	-
	D7 [8]	x	x	-
	D13GE-Tier3 [9]	x	x	x
Perkins Marine Power [3]	GENERIC [0]	x	-	-
	1100 (A4E)	x	-	-
(2) IVECO [4]	GENERIC [0]	x	-	-
	NEF (EDC) [1]	x	-	-
	CURSOR [2]	x	-	-
	CURSOR9 (EDC) [3]	x	-	-
	CURSOR11 [4]	x	-	-
(3) Cummins [6]	GENERIC [0]	x	x	x
	QSX15-G8 (CMS570) [1]	x	x	x
	CM850 [2]	x	-	x
	QSB5 (PGI 1.1) [3]	x	-	x
	QSB7 (PGI 1.1) [4]	x	-	x
	QSL9 (PGI 1.1) [5]	x	-	x
	QSM11 (PGI 1.1) [6]	x	-	x
	QSX15 (CMS570) [7]	x	x	x
	QSK19 (PGI 1.1) [8]	x	-	x
	QSK38 (PGI 1.1) [9]	x	-	x
	QSK50 (PGI 1.1) [10]	x	-	x
	QSK60 (PGI 1.1) [11]	x	-	x
JOHN DEERE [7]	GENERIC [0]	x	-	-
	JDEC [1]	x	-	-
CATERPILLAR [8]	GENERIC [0]	x	-	-
	ADEM A4E2 (C4.4 & C6.6) [1]	x	-	-
[9] DEUTZ FAHR	GENERIC [0]	x	-	-
	EMR [1]	x	-	-
	EMR2 [2]	x	-	-
	EMR3 [3]	x	-	-
mtu [10] See Appendix MTU	GENERIC [0]	-	x	x
	ADEC-2000 [1]	-	x	x
	ADEC-4000 [2]	-	x	x
	ECU8 + Smart Connect [3]	x	x	x
	ECU8 + SAM [4]	-	x	x
DETROIT DIESEL [11]	GENERIC [0]	-	-	-
	DDEC III [1]	-	-	-
	DDEC IV [2]	-	-	-
	DDEC X [3]	-	-	-

(3) Cummins 109G ECU may not support speed control through J1939. ECU with Cummins G Drive firmware should support J1939 speed control

8 RESOURCES FOR SETUP & MAINTENANCE

GENSYS handles several files used for setup or maintenance.

The Configuration file allows you to:

- Set the value of every setting
- Change the units of analog inputs (example: V, mbar, psi, …)
- Change the accuracy when displaying analog values (example: 24V or 24.0V)
- Change the labels of inputs and the screensaver

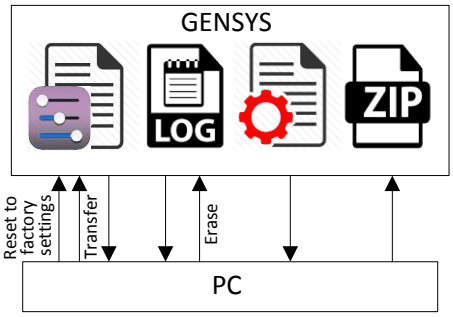
The log file contains the history of time-stamped data (alarm/faults, FIFO data as selected in CRE Config/Configuration/Logger). It is used for maintenance.

The action file contains the list of effects of alarm/faults. It is a sub-file of the text file. They are listed out in *8.3, p.105* and *3.3, p.34*.

The firmware upgrade is a zip file.

8.1 FILE TRANSFER

These files can be transferred to or from GENSYS.
Use CRE Config/System/PC transmit-receive OR the web server.



Erase and Reset to factory settings are available in CRE Config (for the latter, select Options/Advanced and connect on level 2).

8.1.1 GENSYS -> PC file transfer

This page allows you to download a file from GENSYS to the PC:

- Configuration file
- Log file
- List of actions on alarms/faults

Note: The file transfer is only possible when the engine is stopped.

Configuration file

To display the current configuration file in an internet browser, select “Configuration file”.

In the web browser, to save this file, right-click in the page with the text file, and select Save as.

CAUTION

To edit a new configuration from the configuration file, it is strongly recommended to use a configuration file compatible with the installed firmware version:

1. Upload the file from GENSYS
2. Modify it
3. Download this new configuration file to GENSYS

Log file

Upload the file. In the web browser, to save the file, right-click in the page with the file, and select Save as.

List of actions on alarm/fault

By selecting "Action on alarm/fault", a file containing all potential alarms/faults and their use is displayed.
To save this file, right-click in the page with the text file, and select Save as.

Example:

```
***** List of actions on Alarm/Fault *****
0 : Disable
1 : Generator electrical fault
2 : Bus electrical fault
3 : Alarm
4 : Fault (Soft shut down)
5 : Security (Hard shut down)
6 : Fault(Soft shut down)+ Help
7 : Gen. Electrical fault + Help
8 : Droop + Alarm
9 : Droop + No start if Static paralleling
10: No start if Static paralleling
```

```
Potential alarm/fault          Actually setup as            ANSI C37-2
V04503  Oil pres fault lvl1    <-- V02364 = 4
V04504  Water Temp lvl1        <-- V02367 = 4
……
```

8.1.2 PC -> GENSYS file transfer

This page allows you to send parameters file, or language file.

1. Click the "Browse..." button
2. Select the file to download
3. Click the "Save" button.

When the operation is completed, a screen shows on the PC.

Note: Before edition it is recommended to save the current configuration with the "GENSYS -> PC" page. The file transfer is only possible when the engine is stopped.

8.1.3 Update firmware

It allows you to update the firmware with the latest version. Connect CRE Config to GENSYS with the level 2 password. Refer to the chapter *Maintenance*.

8.2 TEXT FILE DESCRIPTION

8.2.1 Variable naming

The file named A56 Z0 9 0030x.xls describes each variable.
The variable format is VXYYYY.

X relates to the type of variable:

- 0 and 1: a reading or a real-time value (Voltage phase 1, CAN bus fault …)
- 2, 3 and 4: a setting to store in non-volatile memory (Generator number, Nominal power …)

YYYY is the code of the variable.
The variables are stored in a non-volatile FLASH memory in the unit. It is possible to download or upload them with a PC, which allows the user to save, modify and reuse them later.
All these values are stored in the text file. This chapter describes the layout of the file.

8.2.2 Text file description

The complete unit setup can be contained in a simple text file. This file can be downloaded from GENSYS to be kept on a PC. It can also be manually edited on a PC and sent to GENSYS to fully setup it in a single step.
This text file is made up of different blocks:

- Parameter values
- Label definitions
- Text definitions
- Unit and accuracy definitions

Parameter definition block

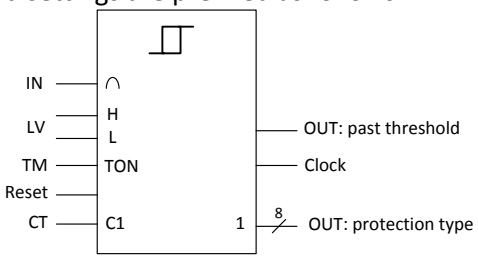
The block start is the {PARAMETERS} statement. Each setting (2000 … 4000) can be found as an input in this block. The structure of the input is as follows:

- The variable parameter number preceded by the letter V (Ex: V01006)
- The label (optional: only for user information) (Ex: Gen Nominal kW)
- The minimal value (optional: only for user information) (Ex: +00000)
- The maximal value (optional: only for user information) (Ex: +65535)
- Unit

Example:

```
{PARAMETERS}
V02000       2            Nb of gen.                    +00001 +00032
V02001       1            GE number                     +00001 +00032
```

In the example above, the generator nominal power is set to 320kW.
The labels related to a threshold settings are prefixed as follows:



The value can be a 4-letter code, especially:

- Validity of digital inputs: 2330, 2329, 2192, 2331 (see further I/O lines)
- Readings shown in the Information page: reading code (without E); see end of chapter HMI

It is possible to modify the values directly in the text file before uploading it into GENSYS. The user must be sure that the modified value is within the minimum / maximum range of the parameter. Failure to do so leads to an error message during uploading (see chapter *9.3, p.115*).
It is also possible to write to an **incomplete** parameter block (not all parameters are displayed in the list). When uploaded, such a file modifies only the parameters which have been entered, the others remain unchanged. This procedure can be used to upload an old text file into a newer module or to activate special features independently.

Label definition block

The block start is the {LABELS} statement. This block is used to define custom labels for CRE Config and the LCD (digital I/Os, analog Is, CANopen I/Os, relay outputs, cycles before maintenance).
Each line of this block contains 2 elements:

- The variable number of the text, preceded by the letter L for label
- The text itself

```
{LABELS}
L01130 Sample label
```

Labels are 14 characters long.
Supported characters include [a...z], [A...Z], [0...9] and the following characters:

<space> ! # $ ( ) * + / : ; < = > [ ] ^ _ . -

All other characters are NOT recommended, as the display may not be the expected one.

Note: All custom labels apply to all languages.

Text definition block

Each line of this block contains 2 elements:

- The variable number of the text, preceded by the letter T
- The text itself

This block includes two items for the logo page and one for hostname:

Text	
T0001	CRE Technology
T0002	www.cretechnology.com
T0003	Hostname

Texts are 21 characters long at most.

Units and accuracy definition block

The block start is the {UNITS} statement.
This block defines what kind of units and accuracy is associated with each analog value.
You need to define only the unit of the analog input itself. All associated parameters (thresholds for instance) are automatically modified accordingly.
The table below lists the different units supported by GENSYS.
Only the three programmable analog inputs have an entry in this block (to get the variable number, refer to the file A56 Z0 9 0030x.xls).
The structure of a unit/accuracy definition consists of the variable number preceded by a letter (U for Unit, A for Accuracy definition) and followed by a code as shown in the examples below. The use of unit and accuracy is described in *8.3.3, p.111*.
The input is as follows:

```
{UNITS}
U00063 07
U02584 00
…
A00063 2
```

The table below shows the list of codes which correspond to the supported accuracies and units. In the examples above, input 0063 is displayed in kW (Unit code = 07) and with two decimal digits (Accuracy code = 2). The input 2584 has no specific unit.

Code	Accuracy	Code	Unit	Code	Unit	Code	Unit	Code	Unit	Code	Unit
		00	" "	**Power-energy**		**Pressure**		**Temperature**		**Time**	
0	1	**Electrical**		07	kW	13	Bar	18	°C	24	s
1	0.1	01	V	08	kWh	14	mBar	19	°F	25	h
2	0.01	02	kV	09	kVAR	15	kPa	**Volume**		26	days
3	0.001	03	mA	10	kVARh	16	PSI	20	L	**Time related**	
		04	A	**Rotating speed**		**Angle**		21	m^3	27	Hz/s
		05	kA	11	rpm	17	°	22	mm^3	28	m^3/h
		Frequency		**Percent**		**Mass**		23	Gal	29	L/h
		06	Hz	12	%	31	kg			30	Gal/h

8.3 I/O LINES

8.3.1 Digital inputs

Each input is tagged with a label defined in CRE Config/Configuration or in the text file, and features several attributes set in the Configuration menu:

- Validity
- Direction
- Delay
- Function

Configurable input label

This is the name you give to the input. The name shows in the info, alarm, and fault screens if programmed accordingly.

Validity

Validity is the epoch when the input is taken into account. It can take four values:

Value		Description
2330	Never	Never active: must be selected if you do not use the input
2329	Always	Always active: input is monitored as long as GENSYS is powered
2192	Post-Start	Input is monitored since the end of the "Safety on delay" [4852] (1)
2331	Stabilized	Input is monitored when the generator is ready for use

(1) Set Safety ON time in the "Timeout" page.

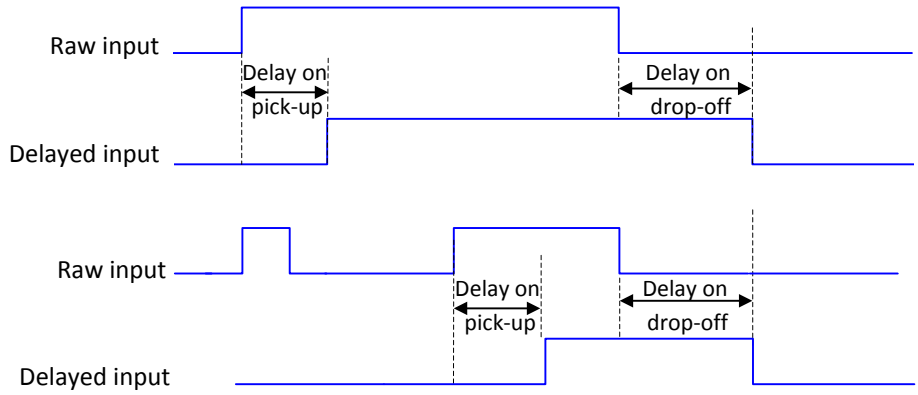
Direction

For each of the inputs, two options are available:

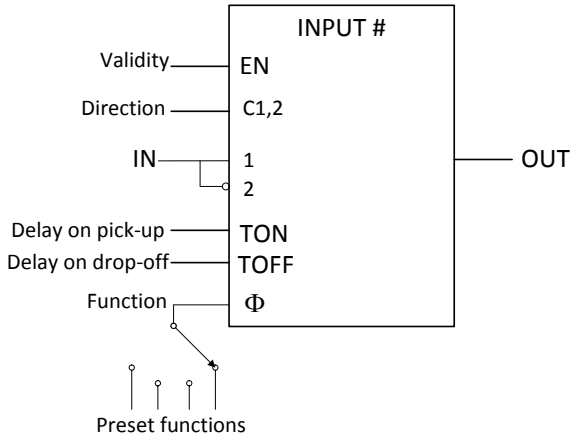
Delays

Num	Label	Function
0	Norm open	Used unless the input is used for protection
1	Norm close	Normally closed; must be selected if the input is normally connected to 0V and is opened when active

For each input, two delays can be defined in 100ms steps between 0 and 6553s.



Summary



Note: If a digital input changes a piece of data also to be written by Modbus, the latest request takes over the other. If 2 digital inputs are assigned to one function, the latest change is taken into account.

Input functions

Function	Use	Ref. chapter
Unused	Must be selected if the input is connected (default value generally)	
Generator breaker feedback	Generator breaker position feedback	*3.5, p.39* *8.4.2, p.114*
Remote start/stop	Remote start/stop of generator start/stop sequence (mode auto)	*3.1.2, p.25*
Only start generator	Allows the engine to run in automatic mode without paralleling nor closing its breaker	*3.2, p.27*
Start crank inhibition	Prevents engine from starting	ibidem
Oil pressure fault	External oil pressure monitoring	ibidem
Coolant temp fault	External temperature monitoring (when the coolant is not water)	ibidem
Emergency stop	Remote stop of generator	*3.2.6, p.33*
Fault reset	External reset. Alternative to local fault reset in Fault and Alarm pages	*0, p.38*
Generator fault request	Fault raised by the generator	*4.4.2, p.46*
Preheating request	For preheating system; used with a digital output, in **manual** mode	*3.2*
Regulated preheating permission	For preheating system; used with a digital output, in **automatic** mode	ibidem
Prelubrication request	For prelubrication pump; used with a digital output, in manual mode	ibidem
Preglow request	For preheating plugs; used with a digital output, in manual mode	ibidem
Generator ready	External start module declares the generator is ready	*3.2, 3.2.4, p.32*
Manual fuel fill request	Manual fuel refilling; used in conjunction with a digital output	*0, p.40*
Manual cool fill request	Manual coolant refilling; used in conjunction with a digital output	ibidem
Manual oil fill request	Manual lubricant refilling; used in conjunction with a digital output	ibidem
Manual start request	Remote start command (alternative to front button)	*3.1.3, p.26*
Manual stop request	Remote stop command (alternative to front button)	ibidem
Manual mode request	Puts GENSYS into manual mode; same effect as MAN key	ibidem
Manual mode inhibition	Inhibits MAN key on the GENSYS front panel	ibidem
Increase speed in man.	Remote frequency increase command (alternative to front button)	ibidem
Decrease speed in man	Remote frequency decrease command (alternative to front button)	ibidem
Increase volt. in man.	Remote voltage increase command (alternative to front button)	ibidem
Decrease volt. in man.	Remote voltage decrease command (alternative to front button)	ibidem

Function	Use	Ref. chapter
Fuel high level	Max level sensor or level calculation; used with a digital output	*0, p.40*
Fuel low level	Min level sensor or level calculation; used with a digital output	ibidem
Coolant high level	Max level sensor or level calculation; used with a digital output	ibidem
Coolant low level	Min level sensor or level calculation; used with a digital output	ibidem
Oil high level	Max level sensor or level calculation; used with a digital output	ibidem
Oil low level	Min level sensor or level calculation; used with a digital output	ibidem
Faults inhibition	Inhibits all protections. Alarms & faults still listed in fault/alarm logger	*0, p.38*
Remote hard shutdown	Immediate stop of the engine by external protections	ibidem
Remote soft shutdown	Immediate opening of generator breaker by external protections and stopping of the engine after cooling down time has expired	ibidem
Remote alarm	If external protections are installed, to report an alarm	ibidem
Remote fault + Help	Stops the engine after cool down. GENSYS requires another engine to start via a remote start input before stopping itself	*4.4.2*
Remote soft shutdown + Help	Activates the "gen electrical fault" action. GENSYS requires another engine to start via a remote start input before stopping itself	ibidem
Stop horn	Selective external reset; in addition, an output must be preset to Horn	*0, p.35*
Gen. breaker Close manual	Remote manual close of generator breaker in manual mode (alternative to front button)	*1.2*
Gen. breaker Open manual	Remote manual opening of generator breaker in manual mode (alternative to front button)	ibidem
Speed set point2 select	Alternative set point	
Volt set point2 select	Alternative set point	
kW set point2 select	Alternative set point	
kW nominal 2 select	Alternative active and reactive nominal powers	
Priority generator	In power management, start-stop depends on a priority generator	*4.4.3*
Unload generator requ if start-stop rule are OK	External pulse request to stop the generator if stopping the engine does not overload aggr according to load dependent start/stop strategy	ibidem
Remote non essential	Order to switch on the load shedding	*0, p.54*
Heavy consm request n	Request to consider powering the heavy consumer #n	**Erreur ! Source**
CAN bus inhibition GEn	Order to logically withdraw from CAnbus the GENSYS whose number is n	*4.4.1, p.45*

8.3.2 Digital outputs

Each input is tagged with a label defined in CRE Config/Configuration or in the text file, and features several attributes set in the Configuration menu:

- Direction
- Function: the output #1 is usually set to “Starter 1” function, the output #2 to “Fuel” function

Directions

Each output can be:

- **NE**: normally energized; the output is **de**-energized when its function is activated
- **ND**: normally de-energized; the output is energized when its function is activated

Output functions

Orders

Function	Receiver	Ref. chapter
Unused	Must be selected if you do not connect the output (default value)	
Water preheating	Preheating system	*3.2*
Pre-lubrication	Pre-lubrication pump	ibidem
Pre glow	Cylinder spark plugs	ibidem
Starter No1	First starter activation	ibidem
Starter No2	Second starter activation	ibidem
Starter No3	Third starter activation	ibidem
Fuel	External fuel relay	ibidem
Excitation cmd	Static paralleling: energizes the AVR excitation relay in states: engine ready, generator ready, wait after stop request, cool down. Dynamic paralleling, see further *Reports*	*4.5.1, p.53*
Energize to stop	External fuel relay if it has to be energized to stop the engine. In manual mode, the triggers are STOP button, the input “Manual stop request”, or the output “Fuel” being deactivated	*3.3 p.33*
Order to close generat. breaker	Alternative to generator breaker relay output (open or close). Can be used to signal tripping	*1.2, p.12*
Soft shutdown + Help	Another GENSYS unit called for help; this output is associated with input Remote Soft shutdown + Help	*4.4.2*
Generator elect. faults + Help	Another GENSYS unit called for help; this output is associated with input Remote Fault + Help	ibidem
Smoke limit/ Position limiting	External speed controller with smoke limit input. Activated on start: • In manual mode, after START is pressed or with “Manual start request” • In auto mode in states “Start”, “Warm up” and “Nominal speed”	*3.2.2, p.31*
Horn	External horn or flashing light. Activated whenever a protection triggers. The output is activated when one or more of summary outputs is activated, and reset on acknowlgt	*0, p.35*
Air conditioning	Air conditioner, activated by input Cool. temp fault (when coolant is not water)	*3.2*
Cooling fan	Air fan, activated by input Coolant temp fault or high water temperature	ibidem
Damper	Damping flap; activated in stop sequence if there is an engine fault	ibidem+ 4.4.2
Fuel tank filling	External fuel pump in conjunction with "Fuel low level" and "Fuel high level" or "Manual fuel fill" functions assigned to digital inputs	*3.7.2, p.40*
Coolant filling	Compressor in conjunction with "Coolant high level" and "Coolant low level" or "Manual air fill" functions assigned to digital inputs	ibidem
Oil filling	External oil pump in conjunction with "Oil high level" and "Oil low level" or "Manual oil fill" functions assigned to digital inputs	ibidem
Increase speed by pulse	Speed regulator requiring +/- contacts. In manual mode, the output is activated when you press the ⮝ key or with an “Increase speed in man”	*1.1, p.12*
Decrease speed by pulse	Speed regulator requiring +/- contacts. In manual mode, the output is activated when you press the ⮟ key or with an “Decrease speed in man”	ibidem
Increase voltage by pulse	*Idem* speed, but with Shift key held down and with an “Increase volt in man” input	ibidem
Decrease voltage by pulse	*Idem* speed, but with Shift key held down and with an “Decrease volt in man” input	ibidem
Start request	The generator has received a remote start and forwards it to ASM	*3.2.4, p.32*
n^{th} non-ess. trip	Load n to be shed after load n–1 (n = 1…5)	*0, p.54*
Non-essential direct trip	Load directly shed	ibidem
n^{th} heavy consum authorization	Heavy consumer #n	***Erreur ! Source du***

States and reports

Function	Description	Ref. chapter
Load request	Reflects the order conveyed over CAN bus by LDSS function	*4.4.3, p.49*
Unload request	*idem*	ibidem
Fail to close gen. breaker	The feedback signal does not indicate the closing	*3.5, p.39*
Fail to open gen. breaker	The feedback signal does not indicate the opening	ibidem
Generator breaker open suddenly	Unexpected opening	ibidem
Generator breaker close	A coil is receiving a 1-sec pulse to close the generator breaker	*8.4.2, p.114*
Generator breaker open	A coil is receiving a 1-sec pulse to open the generator breaker	ibidem
Generator stop	Activated if generator is at rest	*3.2.1, p.27*
Warm up	Activated when engine warms up (warm up clock 2061 is running): • In manual mode, after START is pressed or with Manual start request • In auto mode in states “Start” and “Warm up”	ibidem
Generator ready	Activated if start sequence is completed & voltage is present in generator. In Auto mode, the output is activated when engine state is “Generator ready”	ibidem
Protection valid	The protection are enforced	ibidem
Engine not ready	The speed set point is not reached	ibidem
Excitation cmd	Dynamic paralleling: activated in Start, warm up, & nominal speed	ibidem
Generator voltage presence	Activated if the generator is started and a voltage is detected	*3.2.5, p.33*
Available in automatic	Activated if the generator has completed its start sequence in auto; The power state [4000] does not signal any fault	ibidem
Generator active power flow	Active power direction; de-activated on Generator reverse power	ibidem+*3.5*
Production request	The generator has been elected to start	*0, p.41*
Dead bus bar		*4*
Phase seq match	Phase sequences are the same for synchronization	*0, 4.4.3*
Voltage match	Voltages are close enough for synchronization	ibidem
Frequency match	Frequencies are close enough for synchronization	ibidem
Phase match	Phases are close enough for synchronization	ibidem
Authorization to close breaker	Synchronization request accepted	ibidem
Fail to synchronize	Synchronization request denied	ibidem

Summaries

Function	Description	Ref. chapter
Faults summary	External panel. Trigger: at least one GENSYS-detected “fault”	*3.3, p.34*
Alarms summary	External panel. Trigger: at least one GENSYS-detected “alarm”	ibidem
Hard shutdown summary	External panel. Trigger: at least one “serious fault”	ibidem
Soft shutdown summary	External panel. Trigger: at least one GENSYS-detected “minor fault”	ibidem
GE electrical faults summary	External panel. Trigger: at least one GENSYS-detected “generator electrical fault”	*4.4.2, p.46*
Bus electrical faults summary	External panel. Trigger: at least one GENSYS-detected “bus electrical fault”	ibidem

HMI: reflection of the LED state

Function	Description	Ref. chapter
Faults LED	Reflects the led status	
Alarm LED	idem	
Generator LED	idem	
Manual mode LED	Activated in manual mode	*3.1.3, p. 26*
Auto mode LED	Activated in automatic mode	ibidem
Test mode LED	Activated in test mode	ibidem

J1939 : report of J1939 alarm/fault. Refer to the chapter *7.3.3, p.99*:

Function	Description	Ref. chapter
J1939: High water temper. alarm		*3.2*
J1939: High water temper. fault		ibidem
J1939: Low oil pressure alarm		ibidem
J1939: Low oil pressure fault		ibidem
J1939: Overspeed alarm		
J1939: Overspeed fault		
DM1 engine protection	Diagnostic message DM1	
DM1 warning		
DM1 alarm		
DM1 smoke		*3.2.2, p. 31*

In addition, most protection activations can be reported; refer to the chapter *3.3, p.34:*

Function	Description	Ref. chapter
Min/max analog1	Activated if measurement of analog input 1 is under/over the threshold	*3.3.1, p.34*
Min/max analog2	*Idem* for analog input 2	ibidem
Min/max analog3	*Idem* for analog input 3	ibidem

8.3.3 Analog inputs

In addition to the speed and electrical currents and voltages, three analog inputs are available. They measure a resistance 0…500Ω. However, they can serve as digital inputs or 20 mA transducer input.

Input

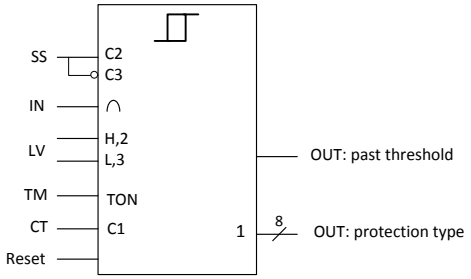
Each input is tagged with a name and preset to a function. It features several attributes preset in CRE Config/Configuration/Inputs/Analog inputs or in the text file:

- Step (number of digits after decimal point) among 1 / 0.1 / 0.01 / 0.001
- Unit, among No unit, V, kV, mA, A, kA, Hz, kW, kWh, kVAR, kVARh, rpm, %, Bar, mBar, kPa, psi, °, °C, °F, L, Gal, s, h, days, Hz/s, m3/h, L/h, Gal/h
- Value range in Ω

Threshold

The input threshold features several attributes preset in CRE Config/Configuration/Protections/ Engine-Battery Protections or in the text file:

- Level (LV): limit value in units; it can be a low or high threshold
- Delay (TM): time after which the trespassing is confirmed
- Validation (CT): protection type to which the signal contributes (8 potential values; see chapter *3.3, p.34*)
- Direction (SS): is it a low (0) or high (1) threshold?



Note: Do not confuse Validation with Validity (engine state that validates a digital input).

Calibration

Calibration is used to estimate a reading from a resistance value by interpolation between 2 wrapping resistance values. Negative values are supported for readings. Enter a table in CRE Config /Configuration/Inputs/Analog inputs/Analog Measure Calibration or in text file.
Select the Accuracy, desired grade of details for tweaking and manual entering: 0.001, 0.01, 0.1 or 1.

Enter the limits of reading according to the sensor calibration; generally the lower limit is 0 and the slope is Range/Rating. Calculate and enter the intermediary readings to get a linear distribution.

Reference table for Oil Pressure:

Ω	VDO 5b	VDO 10b	VDO 25b	AC 10b	Veglia 8b	Veglia 12b	Dat 10b
0	-345	-487	-2 120	-260	8 442	12663	12142
40	834	1 585	3 777	4 316	6 922	10387	8962
80	2 014	3 945	9 674	8 892	5 402	8111	6102
120	3 193	6 245	15 571	13 468	3 882	5835	3562
160	4 372	9 050	21 469	18 044	2 362	3559	1342
200	5 552	12 220	27 366	20 000	842	1283	-558
240	6 731	20 000	30 000	20 000	-678	-993	0
280	7 911	20 000	30 000	20 000	0	0	0
320	9 090	20 000	30 000	20 000	0	0	0

Ω	VDO 5b	VDO 10b	VDO 25b	AC 10b	Veglia 8b	Veglia 12b	Dat 10b
360	10 270	20 000	30 000	20 000	0	0	0
400	11 449	20 000	30 000	20 000	0	0	0

Reference table for Water Temperature:

Ω	VDO 120°	VDO 150°	Veglia	Datcon L	Datcon H	AC
0	145	1000	1000	1000	0	1000
40	96	119	140	104	40	104
80	74	94	118	78	80	78
120	63	80	105	63	120	63
160	55	70	96	52	160	52
200	49	62	89	43	200	43
240	44	56	83	36	240	36
280	40	51	78	31	280	31
320	37	46	74	26	320	26
360	34	42	70	21	360	21
400	32	38	67	17	400	17

Summary

The attributes show in the text file:

	Threshold				
	Level	Delay	Validation	Direction	Function
AI 1 level 1	2600	2601	2602	2606	2607
AI 1 level 2	2603	2604	2605		
AI 2 level 1	2608	2609	2610	2614	2615
AI 2 level 2	2611	2612	2613		
AI 3 level 1	2616	2617	2618	2622	2623
AI 3 level 2	2619	2620	2621		

Use of an analog input as a digital input

To mimic a digital input, connect the input to Power– through a switch, and select the function to implement in the list CRE Config/Configuration/Analog inputs/Function. Refer to *8.3.1, p. 105.*

Use of an analog input as a transceiver input

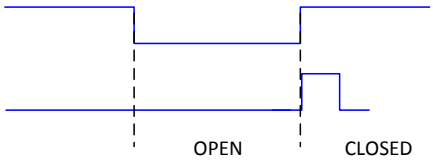
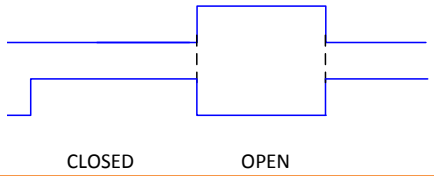
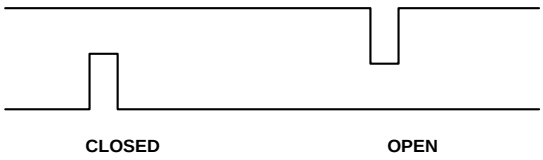
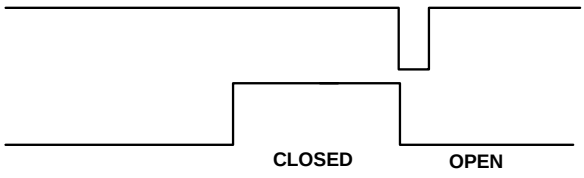
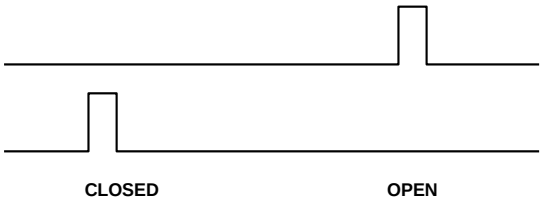
To mimic a 20mA input, connect the input, and select the function 20mA transceiver in the list CRE Config/Configuration/Analog inputs/Function. The non-linearity of the sensor can be corrected through a curve. Select the tweaking grade – the resolution in actual value – in accordance with the sensor accuracy.

8.4 RELAY OUTPUTS

8.4.1 Breaker working modes

GENSYS is equipped with two NO relays to control the generator breaker - one for opening and one for closing. These outputs allow you to control various types of breakers.

Setting	Label	Default	Description
2304	Fail to O/C br	5.0s	Breaker max opening timeout (max. time to get the feedback from breaker). Refer to *3.5, p.39*
2305	Nb br close	1 = 0.1s	Min. time keeping breaker closed. If GENSYS has required to close the breaker, it will not try to open it until the time has elapsed. Unit: tenth of second
2300	Gen brk ctrl	1	Control type of the generator breaker relay. See below

Value	Mode	Time chart of breaker control
0	1: Continuous contact to open 2: Positive pulse to close	
1	1: Continuous contact to open 2: Continuous contact to close	
2	1: Undervoltage (MN) coil opening 2: Pulse to close	
3	1: Undervoltage coil opening 2: Continuous contact to close	
4 (Breaker without under-voltage coil)	1: Pulse to open 2: Pulse to close	
5	1: Pulse to open 2: Continuous contact to close	

WARNING

RISK OF BREAKER STATE MODIFICATION

Do not switch from one mode to another when the plant is in use

Failure to follow this instruction can damage equipment

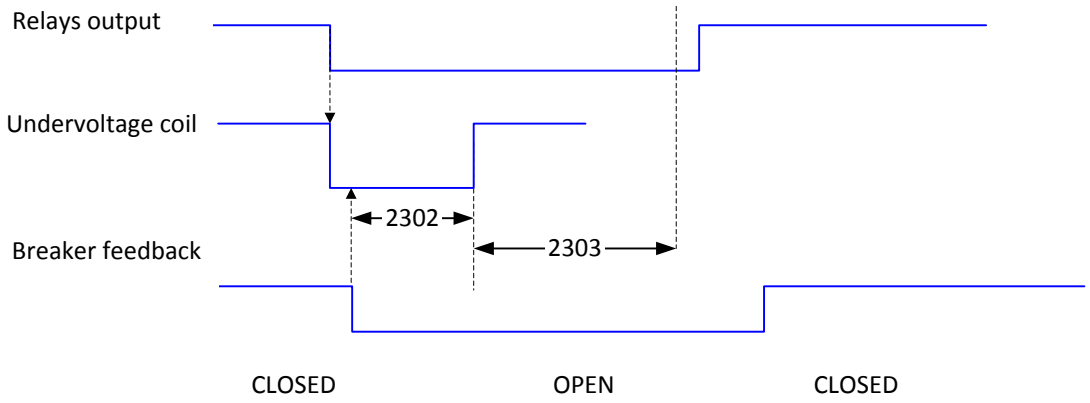
8.4.2 Settings of pulses

Several settings can be modified in "*Configuration/Modification by variable n°*".
Positive pulse:

Setting	Label	Default	Description
2301	Pulse length	10s	Minimum pulse duration

Undervoltage coil:

Setting	Label	Default	Description
2302	UV coil rst	2s	Coil characteristic: pulse hold time after auxiliary contact opening
2303	UV coil pre TM	2s	Security timeout to wait from the pulse end until the other contact be allowed to close in order to close the breaker



To detect the breaker position, assign a digital input to a preset function:

Function	Values
Generator breaker feedback	1 = breaker is closed (reflected in front led)

8.4.3 Related outputs

A digital output, when assigned to these preset function, reports a relay activation:

Function	Report
Generator breaker close	A command closes the generator breaker
Generator breaker open	A command opens the generator breaker

CANopen relay outputs can be used. Refer to the chapter *7.2, p.92*.

9 MAINTENANCE

9.1 UPGRADING THE SOFTWARE

First of all:

- Save the current configuration as a text file; refer to chapter References for setup. Otherwise the default settings will be enforced (except for the IP settings)
- Stop the generator
- Disconnect all the terminals, except the Battery connections.

Then

PC side (web site)	GENSYS side
Connect to CRE Config/System/PC transmit-receive or to GENSYS web site. Select Update firmware. Enter password (level 1 or 2). Browse to the archive (Compact version number.zip) Click Save Wait until *Update firmware successful* shows	 Alarm and Fault LEDs blink Alarm and Fault LEDs are off

At last, restore the settings from the text file.

9.2 ADDING A CUSTOM HMI LANGUAGE

By default, 4 languages are available: English, French, Spanish, Italian.
In addition to English, up to 10 languages can be embedded in GENSYS.
To add your own language:

Translation

Ask for the Excel file.
Fill in the columns for the new language: labels meant for your GENSYS model.
Option: fill in the labels and variable names for CRE Config software.
Return the Excel file.

Downloading

When you receive the related .bin file, in CRE Config/System/PC transmit-receive, select Upload file to GENSYS Compact OR in the website, select PC->GENSYS; browse to this file.
Wait until *Download successful* shows.

Note: Unless the contrary is expressly stipulated, CRE Technology reserves the right to use your translation for other uses.

9.3 TROUBLESHOOTING

To get a history of alarms-faults, stop the generator, connect to CRE Config/System/PC transmit-receive/Download log file from GENSYS Compact, and click Download.

To restore factory settings into CRE Config, navigate to CRE Config/System/PC transmit-receive/Reset factory settings, and click Reset.

Message "Sensor lost" fault on start

In “Configuration/Engine/Speed control settings”, check that the speed measurement origin is accurate (Speed measure = Magnetic or Alternator or J1939).
If it originates in the alternator, check the voltage presence on terminals Gen L1, L2, L3, N.
If it originates in a magnetic pick-up, check that the engine speed increases up to 1500rpm

If the speed does not reach this value on time (the engine stops), increase the "sensor lost" time-out [4203] (default value 5.0s). This time-out is set in CRE Config/Configuration/Time-out and delays.

Message "Oil pressure" fault on start
Check the related connections.
Check the related settings: mainly, delays and directions of digital/analog inputs

Message "CAN bus" fault
Check the related connections, including the one of internal resistor (jumper). Refer to the *Appendix*.
For inter-GENSYS bus, check the related settings: count of generators, number of each generator.

No J1939 communication
Check that the ECU is powered.
Check that the configuration correspond to the engine/ECU.
Check that the wiring is correct. Refer to the *Appendix*.
Power cycle GENSYS and ECU.
Check that the ECU and its settings are consistent with the J1939 standard.
Note: Some ECUs do not provide information if the engine is on stop. Start the engine.

Message "Breaker" fault
Check the type of breaker against the selection in CRE Config/Configuration/Outputs/Breakers.
Stop the other generators.
Make sure the digital input Gen breaker feedback is connected.
Start the generators in manual mode (or just press TEST). Make sure the breaker green led turns on; otherwise, increase the "breaker feedback" time-out [2304] (default value 5.0s). Refer to *3.5, p.39*.

The engine starts but runs above/below nominal speed.
Check the wiring.
Check the fuel supply.
Check the speed output. Refer to *0, p.60.*

No connection with the PC: consider deactivating the firewall.

List of potential error messages when transferring a file to GENSYS

ERROR 001: Only when all gensets are in WAIT state !\n

ERROR 002: Unknown file type\n

ERROR 003: Password must be >=3 \n

ERROR 004: Write data or checksum error\n\r

ERROR 005: Parameter file error\n

ERROR 006: Test production file error\n

ERROR 007: Langue file error\n

ERROR 008: Update failed. Please restart update.\n

ERROR 009: File exceed the limit size of 64ko\n (Only for equation level 3).

ERROR 010: Variable …. doesn't exist.\n

ERROR 011: No write right on variable …. \n

ERROR 012: No write right on label …. \n

ERROR 013: Text …. doesn't exist.\n

ERROR 014: No write right on …. unit\n

ERROR 015: Need password 2 to write on …. variable\n

ERROR 016: No right option to write on …. variable\n

ERROR 017: Configuration not allowing …. variable value\n

ERROR 018: Variable …. out of range\n

ERROR 019: Wrong value for …. variable\n
ERROR 020: Language file not for GENSYS Compact\n
ERROR 021: Too much languages already download\n
ERROR 022: Wrong language file version\n
ERROR 023: Label …. doesn't exist.\n
ERROR 024: Unit …. doesn't exist.\n
ERROR 025: Wrong accuracy value on …. (0,1,2 or 3)\n
ERROR 026: Wrong unit value on …. (from 0 to ….)\n
ERROR 027: No header in language file\n
ERROR 028: No filename found or too long\n
ERROR 029: Wrong accuracy on parameter …. \n

WARNING 001: Wrong size of label …. \n
WARNING 002: Wrong character entered in label …. \n
WARNING 003: Wrong size of text …. \n
WARNING 004: Wrong character entered in text …. \n
WARNING 005: Too many errors...\n
WARNING 006: No unit specify on unit …. \n
WARNING 007: No value specify on parameter …. \n
WARNING 008: No text specify on text …. \n
WARNING 009: No label specify on label …. \n

10 APPENDICES

STANDARDS FOR GENERATORS

ISO 8528-1 CLASSES AND POWER DESIGNATIONS
Various load-duration profiles are defined. Here is the correspondence between classes and powers:

Run	ISO designation	Conditions	Power designation	Conditions	Controller
Unlimited # of hours	PRIME RATING	Allowable average power output over a 24-hour period is 70% of the prime rating. 10% overload	Prime Running Power (changing load)	Overload: max: 1 h over a 12-h period total: 25 h/ year	GENSYS COMPACT PRIME
	CONTINUOUS RATING (base load rating)		Continuous Operating Power	fixed load	ACGEN2.0 (no paralleling)
Limited # of hours	STANDBY RATING	Maximum 200 hours per year. Allowable average power output over a 24-hour period is 70% of the standby rating. No overload	Emergency Stand-by Power (changing load)	25h/ year at 100%. No overload 200 h/year at 80%	TCGEN2.0 (no paralleling)
	MISSION-CRITICAL RATING	Maximum 500 hours per year. Allowable average power output is 85% of the nameplate rating	Limited-Time running Power	fixed load	

ISO 3046

- Part 1: Power: DBR (intermittent) and MCR (Max Continuous Rating).

GENSYS COMPACT offers the possibility to activate air conditioning and a cooling fan.

- Part 4: Speed governor

Governor performance classes	G1	G2	G3	G4
Speed droop	≤ 8%	≤ 5%	≤ 3%	By agreement
Regulation stages	P, PI or PID	P, PI or PID	PI or PID	PI or PID

PI and PID regulations require a load sharing device, such as GENSYS COMPACT.

NEC700 and NFPA110
Start in static paralleling to meet the 10s time limit (NEC700). Type 10 as per NFPA110.
According to NFPA110, Black start is where the stored energy system has the capability to start the prime mover without using energy from another source. Such a generator can be used to start a turbine.
NFA110 defines classes according to fuel tank autonomy; it requires that Emergency Power Supply has a manual remote stop (A5.6.5.6). NFA110 Fault list includes 15 signals (Warning or Shut-down).

NF E37-312
In some public spaces, a Generating Safety Source needs the function Fault inhibition to force the run even though the oil pressure and water temperature safeties are triggered. Some other protections (over speed, overload, etc...) are still active.

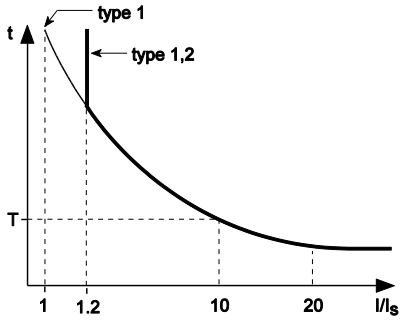
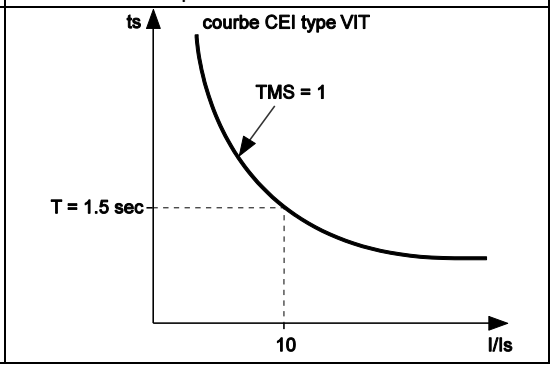
PROTECTION AGAINST SHORT CIRCUITS

The tripping time depends on the duration an alternator winding can endure an over current.

A IDMT curve is defined by:

- a type (IEEE, IEC, IAC)
- Is: current for infinite time in type 1 (asymptote value); type 1.2 is not used
- T: tripping time for I= 10 x Is.

Definition of TMS (Time Multiplier Setting); by default, [2475] = 1:

T is the tripping time for I/Is = 10 (Is= set point, aka threshold)	TMS = 1 corresponds to T= 1.5 s at I = 10 x Is
	

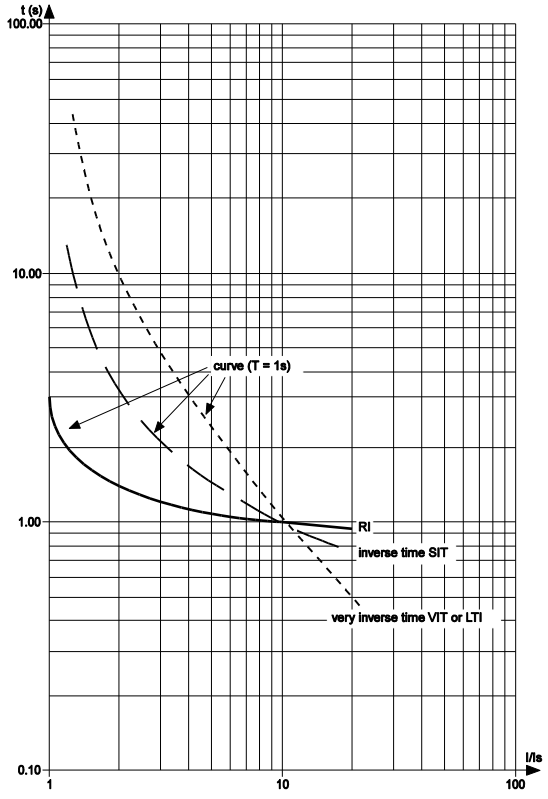
In brief, the higher the overcurrent, the faster the trip.

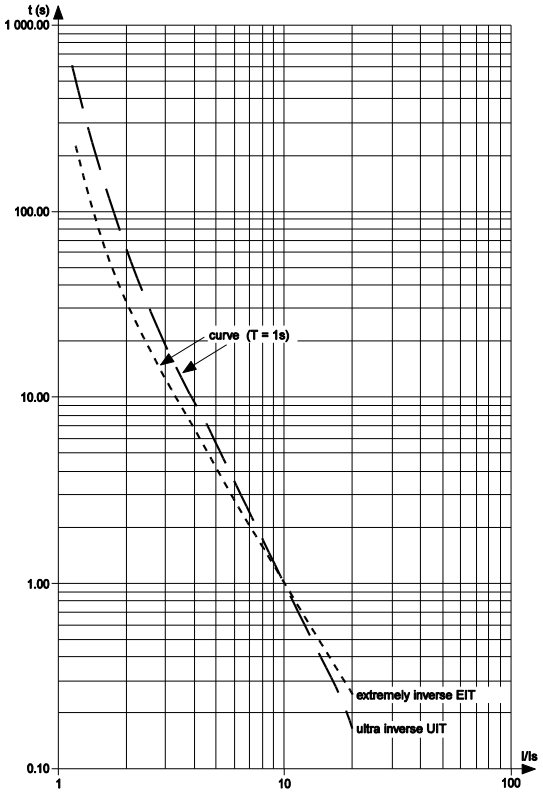
IEC curves

$$t(I) = TMS\ x\ \frac{k}{\left(\frac{I}{Is}\right)^{\alpha} - 1}$$

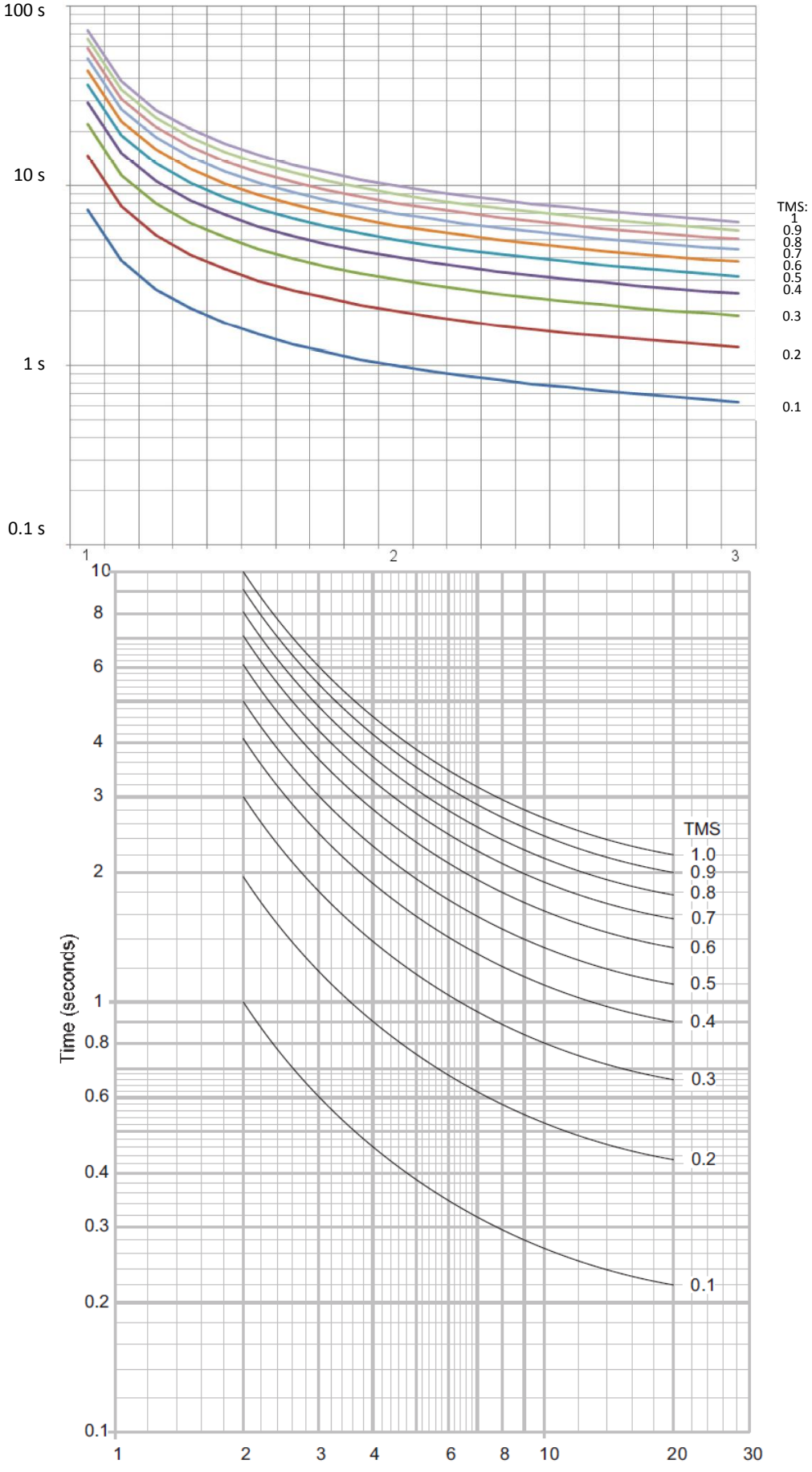
Characteristic curve	k	α (defines type A, B, C)	Selection in CRE Config	β
(Standard) inverse / A	0.14	0.02	Preset	2.97
Very inverse / B	13.5	1	Preset	1.5
Long time inverse / B	120	1	Custom	13.33
Extremely inverse / C	80	2	Preset	0.808
Ultra inverse	315.2	2.5	Custom	

The time from T curves must be divided by β to get the time from TMS curves. T curves where t=1 for I/Is=10:





Inverse curves just above the pick-up value (not logarithmic abscissae I/Is) for various value of TMS:

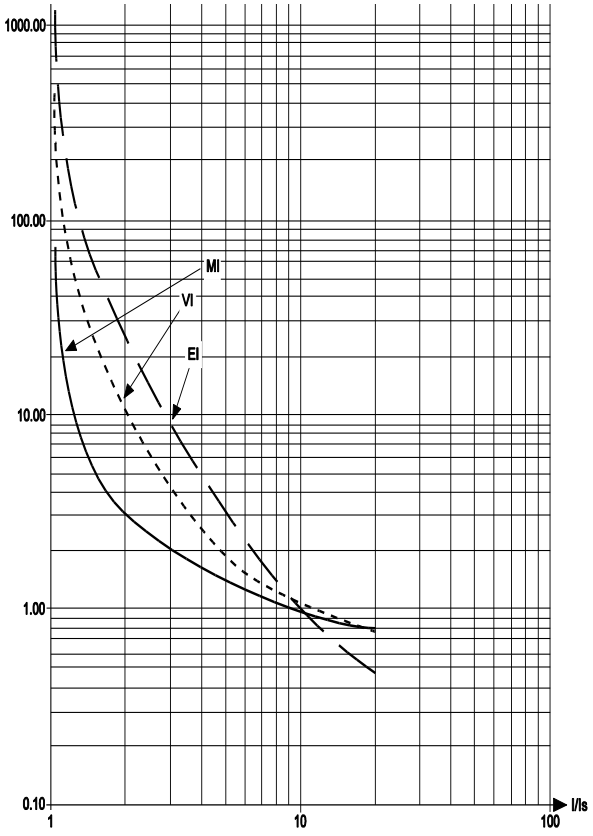


Batch of standard inverse curves

IEEE CURVES

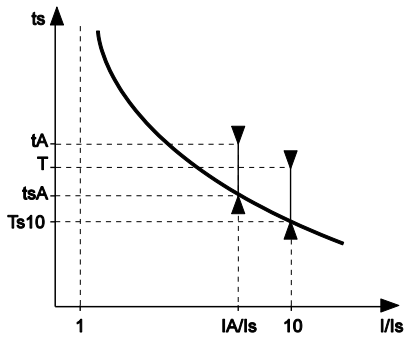
$$t(I) = TMS\ x\ (\frac{\mathrm{k}}{\left(\frac{\mathrm{I}}{\mathrm{Is}}\right)^{\alpha} - 1} + \mathrm{c})$$

Characteristic curve	k	c	α
Moderately inverse	0.515	0.1140	0.02
Very inverse	19.61	0.491	2
Extremely inverse	28.2	0.1217	2



HOW TO DERIVE CURVES BY PARALLELISM

Say a curve is known. We know tsA (s stands for the start curve) for IA/Is (s stands for set point). Two curves with same k, α and c are parallel: K= tsA/Ts10 = tA/T. This can be used to find tA.



In the preceding curves in logarithmic plot, Ts10=1. For a given I/Is (first column of next table), find K in the row. Then ta = K x T.

I/Is	SIT IEC/A	VIT, LTI IEC/B	EIT IEC/C	UIT	RI not av.	IEEE MI IEC/D	IEEE VI IEC/E	IEEE EI IEC/F
1.0	—	—	—	—	3.062	—	—	—
1.1	24.700 (1)	90.000 (1)	471.429 (1)	—	2.534	22.461	136.228	330.606
1.2	12.901	45.000	225.000	545.905	2.216	11.777	65.390	157.946
1.5	5.788	18.000	79.200	179.548	1.736	5.336	23.479	55.791
2.0	3.376	9.000	33.000	67.691	1.427	3.152	10.199	23.421
2.5	2.548	6.000	18.857	35.490	1.290	2.402	6.133	13.512
3.0	2.121	4.500	12.375	21.608	1.212	2.016	4.270	8.970
3.5	1.858	3.600	8.800	14.382	1.161	1.777	3.242	6.465
4.0	1.676	3.000	6.600	10.169	1.126	1.613	2.610	4.924
4.5	1.543	2.571	5.143	7.513	1.101	1.492	2.191	3.903
5.0	1.441	2.250	4.125	5.742	1.081	1.399	1.898	3.190
5.5	1.359	2.000	3.385	4.507	1.065	1.325	1.686	2.671
6.0	1.292	1.800	2.829	3.616	1.053	1.264	1.526	2.281
6.5	1.236	1.636	2.400	2.954	1.042	1.213	1.402	1.981
7.0	1.188	1.500	2.063	2.450	1.033	1.170	1.305	1.744
7.5	1.146	1.385	1.792	2.060	1.026	1.132	1.228	1.555
8.0	1.110	1.286	1.571	1.751	1.019	1.099	1.164	1.400
8.5	1.078	1.200	1.390	1.504	1.013	1.070	1.112	1.273
9.0	1.049	1.125	1.238	1.303	1.008	1.044	1.068	1.166
9.5	1.023	1.059	1.109	1.137	1.004	1.021	1.031	1.077
10.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10.5	0.979	0.947	0.906	0.885	0.996	0.981	0.973	0.934
11.0	0.959	0.900	0.825	0.787	0.993	0.963	0.950	0.877
11.5	0.941	0.857	0.754	0.704	0.990	0.947	0.929	0.828
12.0	0.925	0.818	0.692	0.633	0.988	0.932	0.912	0.784
12.5	0.910	0.783	0.638	0.572	0.985	0.918	0.896	0.746
13.0	0.895	0.750	0.589	0.518	0.983	0.905	0.882	0.712
13.5	0.882	0.720	0.546	0.471	0.981	0.893	0.870	0.682
14.0	0.870	0.692	0.508	0.430	0.979	0.882	0.858	0.655
14.5	0.858	0.667	0.473	0.394	0.977	0.871	0.849	0.631
15.0	0.847	0.643	0.442	0.362	0.976	0.861	0.840	0.609
15.5	0.836	0.621	0.414	0.334	0.974	0.852	0.831	0.589
16.0	0.827	0.600	0.388	0.308	0.973	0.843	0.824	0.571
16.5	0.817	0.581	0.365	0.285	0.971	0.834	0.817	0.555
17.0	0.808	0.563	0.344	0.265	0.970	0.826	0.811	0.540
17.5	0.800	0.545	0.324	0.246	0.969	0.819	0.806	0.527
18.0	0.792	0.529	0.307	0.229	0.968	0.812	0.801	0.514
18.5	0.784	0.514	0.290	0.214	0.967	0.805	0.796	0.503
19.0	0.777	0.500	0.275	0.200	0.966	0.798	0.792	0.492
19.5	0.770	0.486	0.261	0.188	0.965	0.792	0.788	0.482
20.0	0.763	0.474	0.248	0.176	0.964	0.786	0.784	0.473

1) means Only valid for IEC curves

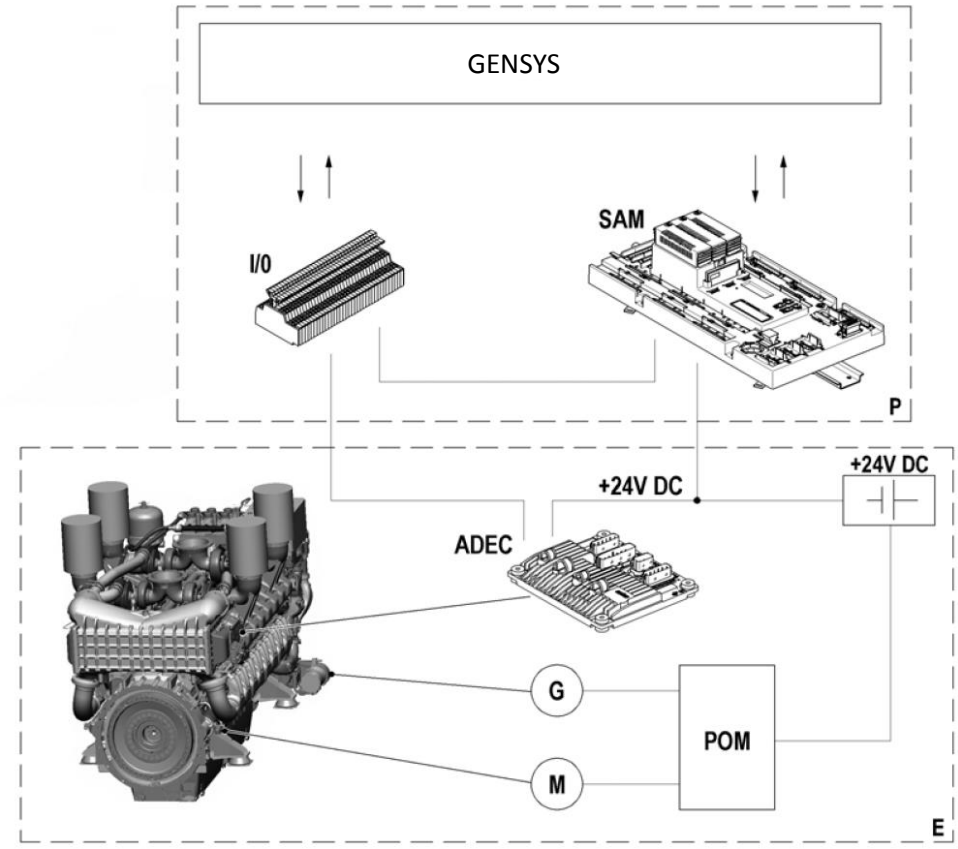
MTU J1939 COMMUNICATION

ADEC

The Service and Automation Module is used in conjunction with the ADEC 2000 or ADEC 4000 governor. The assembly is referred to as ECU7.

Disconnect X13 to switch off the power. Plug the appropriate IO Plugin Card (CCB2) into the SAM slot #3.

The ADEC governor, SAM and GENSYS communicate over the J1939 CAN bus. SAM includes a termination resistor and a CF card.



The ADEC controls the speed. SAM serves as Backup for Engine life data.

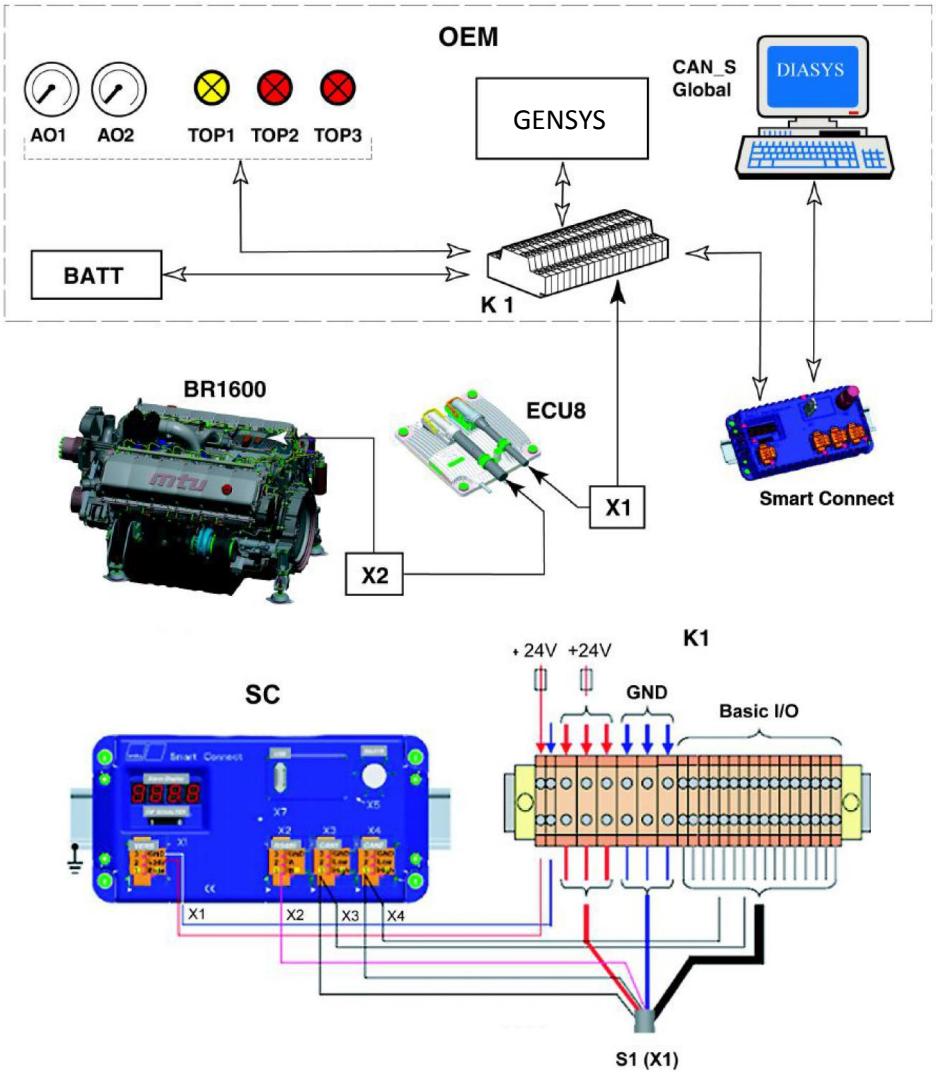
On ECU X1 and X3 connectors are input:

- the engine start/stop requests
- the speed demand (frequency, current or voltage)

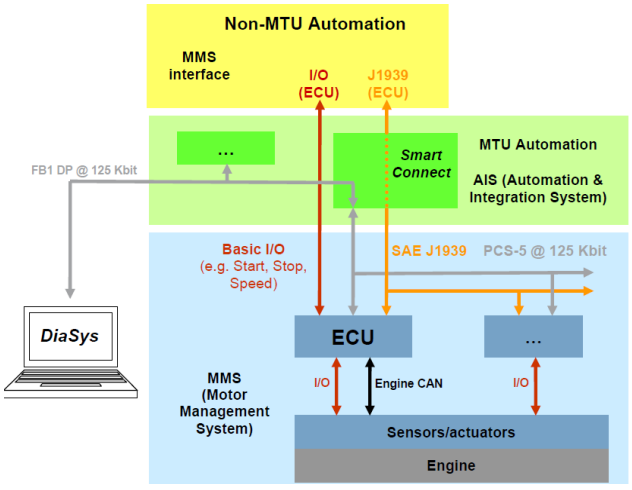
Signal	ADEC X1	Cabinet	SAM X23 connector
CAN High	33	X7-2	2
CAN Low	18	X7-1	1
CAN ground	34	X7-3	3
Speed out +		X2-	
Speed out –		X2-	

ECU8
Smart Connect is used to:

- select the speed set point source through a 3-bit code,
- set the frequency and speed droop
- direct the alarms to a display unit (USB port):



Through the K1 connection box, the bus connect ECU8, Smart Connect and GENSYS. X4 is the Smart Connect J1939 CAN port.



CAN BUS GOOD PRACTICES

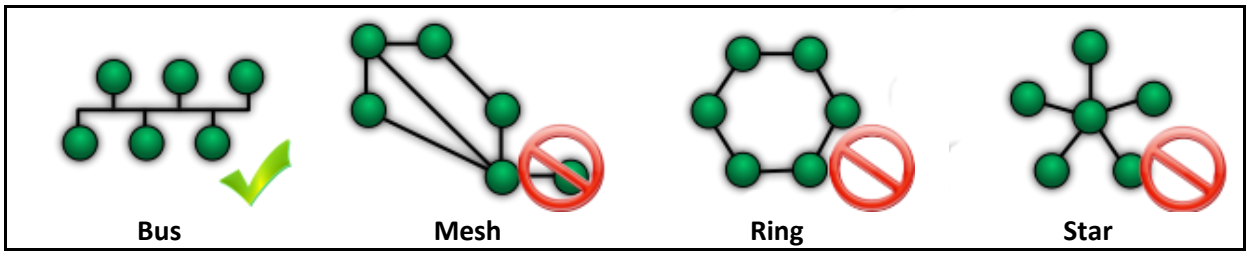
This chapter describes rules to be used to ensure reliable CAN communication. These rules must be applied to all CAN communications, including inter-GENSYS CAN bus and ECU/remote I/O CAN bus.
In an EMI environment, use a shielded cable to connect CAN bus. The table below lists the standard CAN wiring :

Terminal	Standard CAN	Mandatory
1	Reserved	
2	*CAN-L*	*X*
3	CAN GND	X
4	Reserved	
5	CAN SHLD (optional)	
6	GND (optional)	
7	*CAN-H*	*X*
8	Reserved	
9	CAN V+ (optional)	
SHIELD		*X*

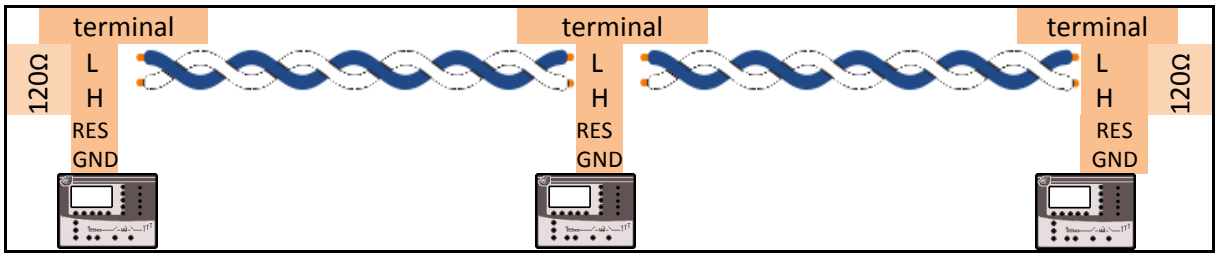
CABLES

WARNING
RISK OF EQUIPMENT DAMAGE
Switch off the unit before plugging or unplugging the CAN bus connector or disconnecting the wires
Failure to follow this instruction can damage the CAN transmitter/receiver

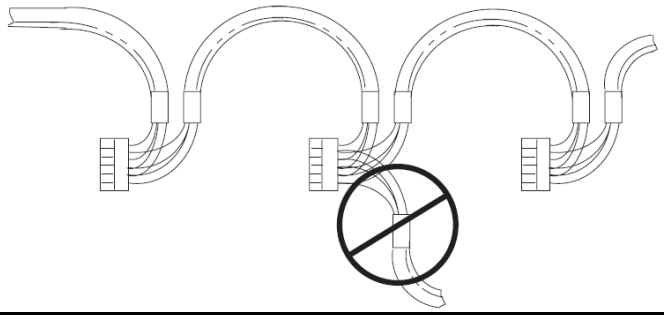
Cables used must be selected to respond to CAN bus specificities. Always use shielded twisted wire pairs. Deploy the CAN bus in a bus (no mesh, ring or star topology) as shown below:



Both ends of the CAN bus must be terminated with a 120Ω resistor.
The next figure gives the example of three units connected through a CAN bus. Do NOT install any resistor in the middle unit and connect the incoming wire and the outgoing wire on the same terminal (max 1.5 mm² or AWG16; use preferably the same section for both).



Daisy chain: it is recommended that the cables draw reversed curves as illustrated (Wye rather than Vee).



CRE Technology provides a complete range of products aimed at installing your CAN bus (cords, wires, connectors…). Please read the document Harness information or contact your local CRE Technology distributor to help you choose equipment that fits your needs.

MAXIMAL LENGTH & BIT RATE

The maximal length of a CAN bus depends mostly on the communication speed, but also on the quality of wires and connectors used.

The following table shows the maximal length of a CAN bus depending on the bit rate.

Bit rate (kbits/s)	10	20	50	125	250	500	800
Maximal length (m)	5000	2500	1000	500	250	100	50

The next table lists the standard bit rate of each CAN protocol that can be used by a CRE Tech. unit:

Bus	Protocol	Bit rate (kbits/s)	Note
CAN1	CRE Technology protocol	125	Fixed
CAN2	CANopen	125 (default)	Can be selected between 125/250/500/1000 kbit/s (By **CRE Config** software or modification by variable number)
	J1939 + CANopen	250	Fixed

CAN1: CRE TECHNOLOGY INTER-UNITS CAN BUS

This CAN bus is used as a communication means between units from a single power plant. Features are:

- Active and reactive load sharing
- Automatic load/unload
- Static paralleling
- Dead bus management
- Other data exchange

Standard CAN bus rules apply here. Refer to previous section to connect units properly on CAN bus.

CAN BUS FAULT

CAN communication between CRE technology units is continuously checked by each unit on the CAN bus. The count of units connected to CAN bus must be the same as the count of units declared inside each unit (count of GENSYS units). Otherwise a CAN bus fault is triggered. This may also occur if:

- Two or more units share the same unit number
- 120Ω termination resistors are not used correctly (see previous section)
- CAN bus cable is not properly connected.

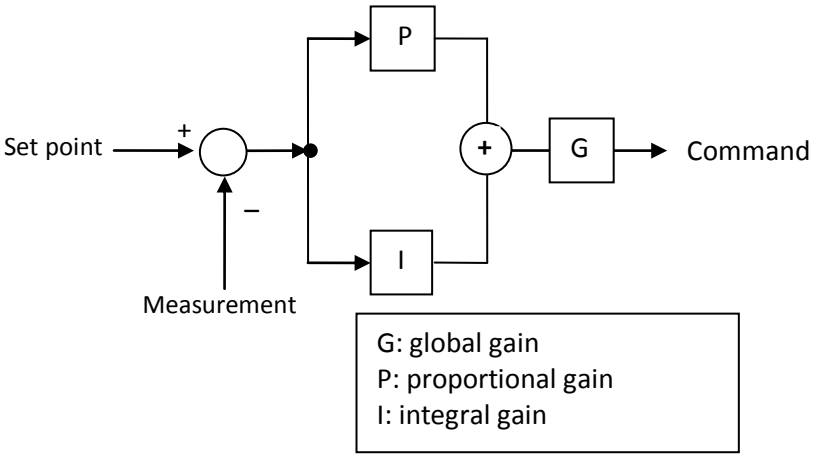
This CAN bus fault can only be reset when the correct count of unit is seen on the CAN bus. As with every protection, the way to handle a CAN bus fault can be selected.

If a remote start occurs on a GENSYS working in automatic mode and set up to manage Dead bus and a CAN bus fault has already been triggered, GENSYS starts its engine and closes its breaker (if there is no voltage on the bus bar) after a delay that depends on the generator number. If there is a voltage on the bus bar, GENSYS synchronizes the generator before connecting to the bus bar.

Note: If you disconnect a GENSYS from the inter GENSYS CAN bus, change the count of generators on ALL other GENSYS units of the power plant.

CONTROL LOOP TUNING

Each control is carried out by two actions: Proportional and Integral.



P adjusts the rise time (time needed for the system to reach its set point for the first time). Using only the P factor always leaves a static error between the set point and the actual value.

I reduces the deviation between the set point and the actual value.
By increasing P or I, the rise time decreases. However, the overshoot increases and may also make the system unstable (P: fast hunting, I: slow hunting).
G is a sensitivity adjustment for the other settings.

Empirical tuning:

A. First set G to 50%
B. Set the parameters P, and I to 0
C. Increase the value of P until the system becomes unstable. From this position, decrease the value of P to 60% of the previous value
D. If the system is unstable, decrease G; if it is too slow, increase G.

Download the list from CRE Config/System/PC transmit-receive/Actions on alarm-fault, and tick the boxes to show how the alarms/faults contribute to severity indication and, if any, summary outputs (grey shade prompts usual choice):

	Generator Overfrequency (81H) H	Generator Overfrequency (81H) HH	Generator Underfrequency (81L) L	Generator Underfrequency (81L) LL	Generator Underervoltage (27) L	Generator Underervoltage (27) LL	Generator Overvoltage (59) H	Generator Overvoltage (59) HH	Min kVAR (37Q) L	Min kVAR (37Q) LL	Max kVAR (32Q) H	Max kVAR (32Q) HH	–kW (32RP) H	–kW (32RP) HH	–kVAR (32RQ) H	–kVAR (32RQ) HH	Min kW (37P) H	Min kW (37P) HH	Max kW (32P) H	Max kW (32P) HH	Max I (51) H	Max I (51) HH	Max In (64G) H	Max In (64G) HH	Short circuit (51) curve	Overspeed (12) H	Overspeed (12) HH	Phase measure	Breaker alarm	Fail to synch (25)	Uneven kW	Uneven kVAR	Bus Overfrequency (81H) H	Bus Overfrequency (81H) HH	Bus Underfrequency (81H) L	Bus Underfrequency (81H) LL	Bus Underervoltage (27) L	Bus Underervoltage (27) LL	Bus Overvoltage (59) H	Bus Overvoltage (59) HH	Min. oil pressure L	Min. oil pressure LL	Max. water temperature H	Max. water temperature HH	Min battery voltage L	Min battery voltage LL	Max battery voltage H	Max battery voltage HH	Over-speed by J1939 H	Over-speed by J1939 HH	Low oil pressure by J1939 L	Low oil pressure by J1939 LL	High water temp. by J1939 H	High water temp. by J1939 HH	Malfunction lamp (J1939)	Protect lamp (J1939)	Amber lamp (J1939)	Red lamp (J1939)	Underfrequency (Load shedding)	Max kW (Load shedding)
1																																																												
2																																																													
3																																																												
4																																																												
5																																																												
6																																																												
7																																																												

1: Generator electrical Fault
2: Bus electrical fault
3: Alarm
4: Fault (soft shutdown)
5: Security (hard shutdown)
6: Fault (soft shutdown + Help)
7: Generator electrical fault + Help
CAN bus faults are not shown.

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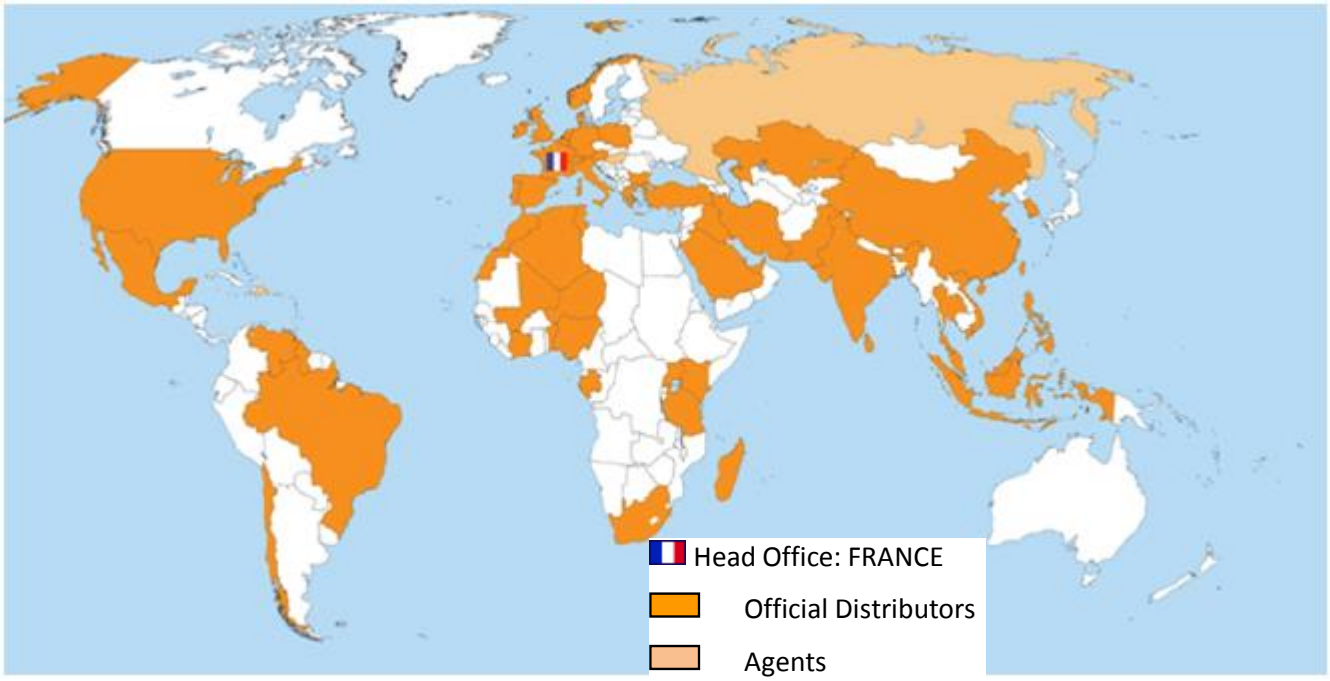
SKYPE: support-cretechnology.com (voice only)

A worldwide coverage:



Check our entire distributors list around the world on our Web site http://www.cretechnology.com.

NEW WEB SITE

www.cretechnology.com

CRE TECHNOLOGY has provided the engine and generator industry for over 25 years with standard products and dedicated solutions for engine control, generator protection and paralleling.

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